

PATENT COOPERATION TREATY

PCT

NOTIFICATION OF ELECTION

(PCT Rule 61.2)

From the INTERNATIONAL BUREAU

To:

Commissioner
US Department of Commerce
United States Patent and Trademark
Office, PCT
2011 South Clark Place Room
CP2/5C24
Arlington, VA 22202
ETATS-UNIS D'AMERIQUE
in its capacity as elected Office

Date of mailing (day/month/year) 29 November 2000 (29.11.00)	
International application No. PCT/US00/10535	Applicant's or agent's file reference 103140-5 PCT
International filing date (day/month/year) 19 April 2000 (19.04.00)	Priority date (day/month/year) 23 April 1999 (23.04.99)
Applicant SMITH, Joshua, R.	

1. The designated Office is hereby notified of its election made:



in the demand filed with the International Preliminary Examining Authority on:

26 October 2000 (26.10.00)

in a notice effecting later election filed with the International Bureau on:

2. The election ☒ was

was not

made before the expiration of 19 months from the priority date or, where Rule 32 applies, within the time limit under Rule 32.2(b).

The International Bureau of WIPO 34, chemin des Colombettes 1211 Geneva 20, Switzerland	Authorized officer Pascal Piriou
Facsimile No.: (41-22) 740.14.35	Telephone No.: (41-22) 338.83.38

INTERNATIONAL COOPERATION TREATY

From the INTERNATIONAL BUREAU

**NOTICE INFORMING THE APPLICANT OF THE
COMMUNICATION OF THE INTERNATIONAL
APPLICATION TO THE DESIGNATED OFFICES**

(PCT Rule 47.1(c), first sentence)

To:

GAGNE, Christopher, K.
Cesari and McKenna, LLP
88 Black Falcon Avenue
Boston, MA 02110
ETATS-UNIS D'AMERIQUE

NOV 20 2000

Date of mailing (day/month/year) 02 November 2000 (02.11.00)		
Applicant's or agent's file reference 103140-5 PCT		IMPORTANT NOTICE
International application No. PCT/US00/10535	International filing date (day/month/year) 19 April 2000 (19.04.00)	Priority date (day/month/year) 23 April 1999 (23.04.99)
Applicant THE ESCHER GROUP, LTD. et al		

1. Notice is hereby given that the International Bureau has communicated, as provided in Article 20, the international application to the following designated Offices on the date indicated above as the date of mailing of this Notice:
AU, KP, KR, US

In accordance with Rule 47.1(c), third sentence, those Offices will accept the present Notice as conclusive evidence that the communication of the international application has duly taken place on the date of mailing indicated above and no copy of the international application is required to be furnished by the applicant to the designated Office(s).

2. The following designated Offices have waived the requirement for such a communication at this time:
AE, AL, AM, AP, AT, AZ, BA, BB, BG, BR, BY, CA, CH, CN, CR, CU, CZ, DE, DK, DM, EA, EE, EP, ES, FI, GB, GD, GE, GH, GM, HR, HU, ID, IL, IN, IS, JP, KE, KG, KZ, LC, LK, LR, LS, LT, LU, LV, MA, MD, MG, MK, MN, MW, MX, NO, NZ, OA, PL, PT, RO, RU, SD, SE, SG, SI, SK, SL, TJ, TM, TR, TT, TZ, UA, UG, UZ, VN, YU, ZA, ZW
The communication will be made to those Offices only upon their request. Furthermore, these Offices do not require the applicant to furnish a copy of the international application (Rule 49.1(a-bis)).

3. Enclosed with this Notice is a copy of the international application as published by the International Bureau on
02 November 2000 (02.11.00) under No. WO 00/65541

REMINDER REGARDING CHAPTER II (Article 31(2)(a) and Rule 54.2)

If the applicant wishes to postpone entry into the national phase until 30 months (or later in some Offices) from the priority date, a demand for international preliminary examination must be filed with the competent International Preliminary Examining Authority before the expiration of 19 months from the priority date.

It is the applicant's sole responsibility to monitor the 19-month time limit.

Note that only an applicant who is a national or resident of a PCT Contracting State which is bound by Chapter II has the right to file a demand for international preliminary examination.

REMINDER REGARDING ENTRY INTO THE NATIONAL PHASE (Article 22 or 39(1))

If the applicant wishes to proceed with the international application in the national phase, he must, within 20 months or 30 months, or later in some Offices, perform the acts referred to therein before each designated or elected Office.

For further important information on the time limits and acts to be performed for entering the national phase, see the Annex to Form PCT/IB/301 (Notification of Receipt of Record Copy) and Volume II of the PCT Applicant's Guide.

The International Bureau of WIPO 34, chemin des Colombettes 1211 Geneva 20, Switzerland	Authorized officer J. Zahra
Facsimile No. (41-22) 740.14.35	Telephone No. (41-22) 338.83.38

This sheet is not part of and does not count as a sheet of the international application.

PCT

FEE CALCULATION SHEET
Annex to the Request

For receiving Office use only

International application No.

Date stamp of the receiving Office

Applicant's or agent's
file reference

103140-5PCT

Applicant

THE ESCHER GROUP, INC.

CALCULATION OF PRESCRIBED FEES

1. TRANSMITTAL FEE 240 T
2. SEARCH FEE 990 S

International search to be carried out by EPO
(If two or more International Searching Authorities are competent in relation to the international application, indicate the name of the Authority which is chosen to carry out the international search.)

3. INTERNATIONAL FEE

Basic Fee

The international application contains 53 sheets.

first 30 sheets 427 b1

23 x 10 = 230 b2

remaining sheets additional amount

Add amounts entered at b1 and b2 and enter total at B 657 B

Designation Fees

The international application contains ALL designations.

8 x 92 = 736 D

number of designation fees payable (maximum 8) amount of designation fee

Add amounts entered at B and D and enter total at I 1393 I

(Applicants from certain States are entitled to a reduction of 75% of the international fee. Where the applicant is (or all applicants are) so entitled, the total to be entered at I is 25% of the sum of the amounts entered at B and D.)

4. FEE FOR PRIORITY DOCUMENT (if applicable) 15 P

5. TOTAL FEES PAYABLE USD 2638

Add amounts entered at T, S, I and P, and enter total in the TOTAL box

TOTAL

☐ The designation fees are not paid at this time.

MODE OF PAYMENT

☐ authorization to charge
deposit account (see below)

☒ cheque

☐ postal money order

☐ bank draft

☐ cash

☐ revenue stamps

☐ coupons

☐ other (specify):

DEPOSIT ACCOUNT AUTHORIZATION (this mode of payment may not be available at all receiving Offices)

The RO/ US ☐ is hereby authorized to charge the total fees indicated above to my deposit account.

☒ (this check-box may be marked only if the conditions for deposit accounts of the receiving Office so permit) is hereby authorized to charge any deficiency or credit any overpayment in the total fees indicated above to my deposit account.

☐ is hereby authorized to charge the fee for preparation and transmittal of the priority document to the International Bureau of WIPO to my deposit account.

03-1237

Deposit Account No

Date (day/month/year)

19/4/00

Signature

Christopher Hap

PATENT COOPERATION TREATY

Appointment of Agent

The undersigned Applicants, The Escher Group, Ltd. and Joshua R. Smith, hereby appoint Michael E. Attaya, Reg. No. 31,731; Charles J. Barbas, Reg. No. 32,959; Joseph H. Born, Reg. No. 28,283; Robert A. Ccsari, Reg. No. 18,381; Yong S. Choi, Reg. No. 43,324; Brian C. Dauphin, Reg. No. 40,983; Steven J. Frank, Reg. No. 33,497; Christopher K. Gagne, Reg. No. 36,142; A. Sidney Johnston, Reg. No. 29,548; William A. Loginov, Reg. No. 34,863; John F. McKenna, Reg. No. 20,912; Rama B. Nath, Reg. No. 27,072; Martin J. O'Donnell, Reg. No. 24,204; Thomas C. O'Konski, Reg. No. 26,320; Michael R. Reinemann, Reg. No. 38,280; Rita M. Rooney, Reg. No. 30,585; Heather B. Shapiro, Reg. No. 41,305; Patricia A. Sheehan, Reg. No. 32,301; and Joseph Stecewycz, Reg. No. 34,442, Cesari and McKenna, LLP, Attorneys at Law, 30 Rowes Wharf, 5th Floor, Boston, Massachusetts, 02110, as agent(s) to act on their behalf before the competent International Authorities in connection with the Patent Cooperation Treaty Application filed herewith, and identified as follows:

Title: WORKPIECE AUTHENTICATION BASED UPON ONE OR MORE
WORKPIECE IMAGES

Based On: United States Provisional Patent Application No. 60/130,666
filed with the United States Patent and Trademark Office on
April 23, 1999

Attorney's Docket No.: 103140-0005PCT

The aforesaid attorneys are further authorized to receive payments on behalf of the Applicant.

[PLACE] Cambridge, Massachusetts

[DATE] 4/11/2000

THE ESCHER GROUP, LTD.

BY:


Andrew V. Sutherland

Paul D Birch
Chief Financial Officer
Chief Operating Officer

PATENTS
103140-0005PCT

Cambridge, Massachusetts
[PLACE]

4/11/2000
[DATE]

BY: 
SM/H, Joshua R.

PCT

FEE CALCULATION SHEET

Annex to the Demand for international preliminary examination

<table border="1" style="width: 100%; border-collapse: collapse;"> <tr> <td style="width: 30%;">International application No.</td> <td>PCT/US00/10535</td> </tr> <tr> <td>Applicant's or agent's file reference</td> <td>103140-5PCT</td> </tr> </table>	International application No.	PCT/US00/10535	Applicant's or agent's file reference	103140-5PCT	<div style="border: 1px solid black; padding: 5px;"> For International Preliminary Examining Authority use only </div> <div style="border: 1px solid black; height: 100px; margin-top: 10px;"> Date stamp of the IPEA </div>
International application No.	PCT/US00/10535				
Applicant's or agent's file reference	103140-5PCT				
Applicant The Escher Group, Ltd.					
Calculation of prescribed fees					
1. Preliminary examination fee	<div style="border: 1px solid black; display: inline-block; padding: 2px 10px;">2998.29DM</div> <div style="border: 1px solid black; display: inline-block; padding: 2px 5px; margin-left: 5px;">P</div>				
2. Handling fee (<i>Applicants from certain States are entitled to a reduction of 75% of the handling fee. Where the applicant is (or all applicants are) so entitled, the amount to be entered at H is 25% of the handling fee.</i>)	<div style="border: 1px solid black; display: inline-block; padding: 2px 10px;">289.46DM</div> <div style="border: 1px solid black; display: inline-block; padding: 2px 5px; margin-left: 5px;">H</div>				
3. Total of prescribed fees Add the amounts entered at P and H and enter total in the TOTAL box	<div style="border: 1px solid black; display: inline-block; padding: 2px 10px;">3287.75DM</div>				
<div style="border: 1px solid black; padding: 2px;">TOTAL</div>					
Mode of Payment					
<input type="checkbox"/> authorization to charge deposit account with the IPEA (see below)	<input type="checkbox"/> cash				
<input type="checkbox"/> cheque	<input type="checkbox"/> revenue stamps				
<input type="checkbox"/> postal money order	<input type="checkbox"/> coupons				
<input checked="" type="checkbox"/> bank draft	<input type="checkbox"/> other (specify):				
Deposit Account Authorization (<i>this mode of payment may not be available at all IPEAs</i>)					
The IPEA/ <u>EPO</u> <input type="checkbox"/> is hereby authorized to charge the total fees indicated above to my deposit account.					
<input checked="" type="checkbox"/> (<i>this check-box may be marked only if the conditions for deposit accounts of the IPEA so permit</i>) is hereby authorized to charge any deficiency or credit any overpayment in the total fees indicated above to my deposit account.					
<u>28300290</u> Deposit Account Number	<u>24/10/00</u> Date (day/month/year)				
<div style="text-align: right;"> Signature </div>					

PCT

REQUEST

The undersigned requests that the present international application be processed according to the Patent Cooperation Treaty.

For receiving Office use only

International Application No.

International Filing Date

Name of receiving Office and "PCT International Application"

Applicant's or agent's file reference
(if desired) (12 characters maximum)

103140-5PCT

Box No. I TITLE OF INVENTION **WORKPIECE AUTHENTICATION BASED UPON ONE OR MORE WORKPIECE IMAGES**

Box No. II APPLICANT

Name and address: (Family name followed by given name; for a legal entity, full official designation. The address must include postal code and name of country. The country of the address indicated in this Box is the applicant's State (that is, country) of residence if no State of residence is indicated below.)

**THE ESCHER GROUP, LTD.
101 Main Street, 12th Floor
Cambridge, Massachusetts 02142
United States of America**

☐ This person is also inventor.

Telephone No.

(617) 234-8910

Facsimile No.

(617) 497-3910

Teleprinter No.

State (that is, country) of nationality:

US

State (that is, country) of residence:

US

This person is applicant for the purposes of:

☐ all designated States

☒ all designated States except the United States of America

☐ the United States of America only

☐ the States indicated in the Supplemental Box

Box No. III FURTHER APPLICANT(S) AND/OR (FURTHER) INVENTOR(S)

Name and address: (Family name followed by given name; for a legal entity, full official designation. The address must include postal code and name of country. The country of the address indicated in this Box is the applicant's State (that is, country) of residence if no State of residence is indicated below.)

**SMITH, Joshua R.
194 Norfolk Street
Cambridge, Massachusetts 02139
United States of America**

This person is:

☐ applicant only

☒ applicant and inventor

☐ inventor only (If this check-box is marked, do not fill in below.)

State (that is, country) of nationality:

US

State (that is, country) of residence:

US

This person is applicant for the purposes of:

☐ all designated States

☐ all designated States except the United States of America

☒ the United States of America only

☐ the States indicated in the Supplemental Box

☐ Further applicants and/or (further) inventors are indicated on a continuation sheet.

Box No. IV AGENT OR COMMON REPRESENTATIVE; OR ADDRESS FOR CORRESPONDENCE

The person identified below is hereby/has been appointed to act on behalf of the applicant(s) before the competent International Authorities as:

☒ agent

☐ common representative

Name and address: (Family name followed by given name; for a legal entity, full official designation. The address must include postal code and name of country.)

**GAGNE, Christopher K.
Cesari and McKenna, LLP
30 Rows Wharf
Boston, Massachusetts 02110
United States of America**

Telephone No.

(617) 951-3050

Facsimile No.

(617) 951-3927

Teleprinter No.

☐ Address for correspondence: Mark this check-box where no agent or common representative is/has been appointed and the space above is used instead to indicate a special address to which correspondence should be sent.

Box No.V DESIGNATION OF STATES

The following designations are hereby made under Rule 4.9(a) (mark the applicable check-boxes; at least one must be marked):

Regional Patent

- ☒ **AP** ARIPO Patent: GH Ghana, GM Gambia, KE Kenya, LS Lesotho, MW Malawi, SD Sudan, SL Sierra Leone, SZ Swaziland, TZ United Republic of Tanzania, UG Uganda, ZW Zimbabwe, and any other State which is a Contracting State of the Harare Protocol and of the PCT
- ☒ **EA** Eurasian Patent: AM Armenia, AZ Azerbaijan, BY Belarus, KG Kyrgyzstan, KZ Kazakhstan, MD Republic of Moldova, RU Russian Federation, TJ Tajikistan, TM Turkmenistan, and any other State which is a Contracting State of the Eurasian Patent Convention and of the PCT
- ☒ **EP** European Patent: AT Austria, BE Belgium, CH and LI Switzerland and Liechtenstein, CY Cyprus, DE Germany, DK Denmark, ES Spain, FI Finland, FR France, GB United Kingdom, GR Greece, IE Ireland, IT Italy, LU Luxembourg, MC Monaco, NL Netherlands, PT Portugal, SE Sweden, and any other State which is a Contracting State of the European Patent Convention and of the PCT
- ☒ **OA** OAPI Patent: BF Burkina Faso, BJ Benin, CF Central African Republic, CG Congo, CI Côte d'Ivoire, CM Cameroon, GA Gabon, GN Guinea, GW Guinea-Bissau, ML Mali, MR Mauritania, NE Niger, SN Senegal, TD Chad, TG Togo, and any other State which is a member State of OAPI and a Contracting State of the PCT (if other kind of protection or treatment desired, specify on dotted line)

National Patent (if other kind of protection or treatment desired, specify on dotted line):

- | | |
|---|---|
| <input checked="" type="checkbox"/> AE United Arab Emirates | <input checked="" type="checkbox"/> LR Liberia |
| <input checked="" type="checkbox"/> AL Albania | <input checked="" type="checkbox"/> LS Lesotho |
| <input checked="" type="checkbox"/> AM Armenia | <input checked="" type="checkbox"/> LT Lithuania |
| <input checked="" type="checkbox"/> AT Austria | <input checked="" type="checkbox"/> LU Luxembourg |
| <input checked="" type="checkbox"/> AU Australia | <input checked="" type="checkbox"/> LV Latvia |
| <input checked="" type="checkbox"/> AZ Azerbaijan | <input checked="" type="checkbox"/> MA Morocco |
| <input checked="" type="checkbox"/> BA Bosnia and Herzegovina | <input checked="" type="checkbox"/> MD Republic of Moldova |
| <input checked="" type="checkbox"/> BB Barbados | <input checked="" type="checkbox"/> MG Madagascar |
| <input checked="" type="checkbox"/> BG Bulgaria | <input checked="" type="checkbox"/> MK The former Yugoslav Republic of Macedonia |
| <input checked="" type="checkbox"/> BR Brazil | <input checked="" type="checkbox"/> MN Mongolia |
| <input checked="" type="checkbox"/> BY Belarus | <input checked="" type="checkbox"/> MW Malawi |
| <input checked="" type="checkbox"/> CA Canada | <input checked="" type="checkbox"/> MX Mexico |
| <input checked="" type="checkbox"/> CH and LI Switzerland and Liechtenstein | <input checked="" type="checkbox"/> NO Norway |
| <input checked="" type="checkbox"/> CN China | <input checked="" type="checkbox"/> NZ New Zealand |
| <input checked="" type="checkbox"/> CR Costa Rica | <input checked="" type="checkbox"/> PL Poland |
| <input checked="" type="checkbox"/> CU Cuba | <input checked="" type="checkbox"/> PT Portugal |
| <input checked="" type="checkbox"/> CZ Czech Republic | <input checked="" type="checkbox"/> RO Romania |
| <input checked="" type="checkbox"/> DE Germany | <input checked="" type="checkbox"/> RU Russian Federation |
| <input checked="" type="checkbox"/> DK Denmark | <input checked="" type="checkbox"/> SD Sudan |
| <input checked="" type="checkbox"/> DM Dominica | <input checked="" type="checkbox"/> SE Sweden |
| <input checked="" type="checkbox"/> EE Estonia | <input checked="" type="checkbox"/> SG Singapore |
| <input checked="" type="checkbox"/> ES Spain | <input checked="" type="checkbox"/> SI Slovenia |
| <input checked="" type="checkbox"/> FI Finland | <input checked="" type="checkbox"/> SK Slovakia |
| <input checked="" type="checkbox"/> GB United Kingdom | <input checked="" type="checkbox"/> SL Sierra Leone |
| <input checked="" type="checkbox"/> GD Grenada | <input checked="" type="checkbox"/> TJ Tajikistan |
| <input checked="" type="checkbox"/> GE Georgia | <input checked="" type="checkbox"/> TM Turkmenistan |
| <input checked="" type="checkbox"/> GH Ghana | <input checked="" type="checkbox"/> TR Turkey |
| <input checked="" type="checkbox"/> GM Gambia | <input checked="" type="checkbox"/> TT Trinidad and Tobago |
| <input checked="" type="checkbox"/> HR Croatia | <input checked="" type="checkbox"/> TZ United Republic of Tanzania |
| <input checked="" type="checkbox"/> HU Hungary | <input checked="" type="checkbox"/> UA Ukraine |
| <input checked="" type="checkbox"/> ID Indonesia | <input checked="" type="checkbox"/> UG Uganda |
| <input checked="" type="checkbox"/> IL Israel | <input checked="" type="checkbox"/> US United States of America |
| <input checked="" type="checkbox"/> IN India | |
| <input checked="" type="checkbox"/> IS Iceland | |
| <input checked="" type="checkbox"/> JP Japan | <input checked="" type="checkbox"/> UZ Uzbekistan |
| <input checked="" type="checkbox"/> KE Kenya | <input checked="" type="checkbox"/> VN Viet Nam |
| <input checked="" type="checkbox"/> KG Kyrgyzstan | <input checked="" type="checkbox"/> YU Yugoslavia |
| <input checked="" type="checkbox"/> KP Democratic People's Republic of Korea | <input checked="" type="checkbox"/> ZA South Africa |
| | <input checked="" type="checkbox"/> ZW Zimbabwe |

Check-boxes reserved for designating States which have become party to the PCT after issuance of this sheet:



Precautionary Designation Statement: In addition to the designations made above, the applicant also makes under Rule 4.9(b) all other designations which would be permitted under the PCT except any designation(s) indicated in the Supplemental Box as being excluded from the scope of this statement. The applicant declares that those additional designations are subject to confirmation and that any designation which is not confirmed before the expiration of 15 months from the priority date is to be regarded as withdrawn by the applicant at the expiration of that time limit. (Confirmation (including fees) must reach the receiving Office within the 15-month time limit.)

Supplemental Box If the Supplemental Box is not used, this sheet should not be included in the request.

1. If, in any of the Boxes, the space is insufficient to furnish all the information: in such case, write "Continuation of Box No. ..." [indicate the number of the Box] and furnish the information in the same manner as required according to the captions of the Box in which the space was insufficient, in particular:

- (i) if more than two persons are involved as applicants and/or inventors and no "continuation sheet" is available: in such case, write "Continuation of Box No. III" and indicate for each additional person the same type of information as required in Box No. III. The country of the address indicated in this Box is the applicant's State (that is, country) of residence if no State of residence is indicated below;
 - (ii) if, in Box No. II or in any of the sub-boxes of Box No. III, the indication "the States indicated in the Supplemental Box" is checked: in such case, write "Continuation of Box No. II" or "Continuation of Box No. III" or "Continuation of Boxes No. II and No. III" (as the case may be), indicate the name of the applicant(s) involved and, next to (each) such name, the State(s) (and/or, where applicable, ARIPO, Eurasian, European or OAPI patent) for the purposes of which the named person is applicant;
 - (iii) if, in Box No. II or in any of the sub-boxes of Box No. III, the inventor or the inventor/applicant is not inventor for the purposes of all designated States or for the purposes of the United States of America: in such case, write "Continuation of Box No. II" or "Continuation of Box No. III" or "Continuation of Boxes No. II and No. III" (as the case may be), indicate the name of the inventor(s) and, next to (each) such name, the State(s) (and/or, where applicable, ARIPO, Eurasian, European or OAPI patent) for the purposes of which the named person is inventor;
 - (iv) if, in addition to the agent(s) indicated in Box No. IV, there are further agents: in such case, write "Continuation of Box No. IV" and indicate for each further agent the same type of information as required in Box No. IV;
 - (v) if, in Box No. V, the name of any State (or OAPI) is accompanied by the indication "patent of addition," or "certificate of addition," or if, in Box No. V, the name of the United States of America is accompanied by an indication "continuation" or "continuation-in-part": in such case, write "Continuation of Box No. V" and the name of each State involved (or OAPI), and after the name of each such State (or OAPI), the number of the parent title or parent application and the date of grant of the parent title or filing of the parent application;
 - (vi) if, in Box No. VI, there are more than three earlier applications whose priority is claimed: in such case, write "Continuation of Box No. VI" and indicate for each additional earlier application the same type of information as required in Box No. VI;
 - (vii) if, in Box No. VI, the earlier application is an ARIPO application: in such case, write "Continuation of Box No. VI", specify the number of the item corresponding to that earlier application and indicate at least one country party to the Paris Convention for the Protection of Industrial Property or one Member of the World Trade Organization for which that earlier application was filed.
2. If, with regard to the precautionary designation statement contained in Box No. V, the applicant wishes to exclude any State(s) from the scope of that statement: in such case, write "Designation(s) excluded from precautionary designation statement" and indicate the name or two-letter code of each State so excluded.
3. If the applicant claims, in respect of any designated Office, the benefits of provisions of the national law concerning non-prejudicial disclosures or exceptions to lack of novelty: in such case, write "Statement concerning non-prejudicial disclosures or exceptions to lack of novelty" and furnish that statement below.

(CONTINUATION OF BOX NO. IV)

ATTAYA, Michael E.
 BARBAS, Charles J.
 BORN, Joseph H.
 CESARI, Robert A.
 CHOI, Yong
 FRANK, Steven J.
 GAGNE, Christopher K.
 JOHNSTON, A. Sidney
 LOGINOV, William A.
 MCKENNA, John F.
 NATH, Rama B.
 O'DONNELL, Martin J.
 O'KONSKI, Thomas C.
 REINEMANN, Michael R.
 ROONEY, Rita A.
 SHAPIRO, Heather B.
 SHEEHAN, Patricia A.
 STECEWYCZ, Joseph

CESARI AND MCKENNA, LLP
 30 Rowes Wharf
 Boston, MA 02110

See Notes to the request form

Box No. VI PRIORITY CLAIM		<input type="checkbox"/> Further priority claims are indicated in the Supplemental Box.		
Filing date of earlier application (day/month/year)	Number of earlier application	Where earlier application is:		
		national application: country	regional application:* regional Office	international application: receiving Office
item (1) (23/04/99) 23 April 1999	60/130,666	US		
item (2)				
item (3)				

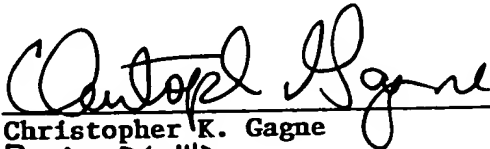
☒ The receiving Office is requested to prepare and transmit to the International Bureau a certified copy of the earlier application(s) (only if the earlier application was filed with the Office which for the purposes of the present international application is the receiving Office) identified above as item(s): **(1)**

* Where the earlier application is an ARIPO application, it is mandatory to indicate in the Supplemental Box at least one country party to the Paris Convention for the Protection of Industrial Property for which that earlier application was filed (Rule 4.10(b)(ii)). See Supplemental Box.

Box No. VII INTERNATIONAL SEARCHING AUTHORITY		
Choice of International Searching Authority (ISA) (if two or more International Searching Authorities are competent to carry out the international search, indicate the Authority chosen; the two-letter code may be used): ISA / EPO	Request to use results of earlier search; reference to that search (if an earlier search has been carried out by or requested from the International Searching Authority): Date (day/month/year) Number Country (or regional Office)	

Box No. VIII CHECK LIST; LANGUAGE OF FILING	
This international application contains the following number of sheets: request : 4 description (excluding sequence listing part) : 25 claims : 16 abstract : 1 drawings : 7 sequence listing part of description : — Total number of sheets : 53	This international application is accompanied by the item(s) marked below: 1. <input checked="" type="checkbox"/> fee calculation sheet 2. <input checked="" type="checkbox"/> separate signed power of attorney 3. <input type="checkbox"/> copy of general power of attorney; reference number, if any: 4. <input type="checkbox"/> statement explaining lack of signature 5. <input type="checkbox"/> priority document(s) identified in Box No. VI as item(s): 6. <input type="checkbox"/> translation of international application into (language): 7. <input type="checkbox"/> separate indications concerning deposited microorganism or other biological material 8. <input type="checkbox"/> nucleotide and/or amino acid sequence listing in computer readable form 9. <input type="checkbox"/> other (specify):

Figure of the drawings which should accompany the abstract: F16.1	Language of filing of the international application: ENGLISH
--	---

Box No. IX SIGNATURE OF APPLICANT OR AGENT	
Next to each signature, indicate the name of the person signing and the capacity in which the person signs (if such capacity is not obvious from reading the request). <div style="text-align: center;">  Christopher K. Gagne Reg No. 36,142 </div>	

For receiving Office use only	
1. Date of actual receipt of the purported international application: 3. Corrected date of actual receipt due to later but timely received papers or drawings completing the purported international application: 4. Date of timely receipt of the required corrections under PCT Article 11(2): 5. International Searching Authority (if two or more are competent): ISA /	2. Drawings: <input type="checkbox"/> received: <input type="checkbox"/> not received: 6. <input type="checkbox"/> Transmittal of search copy delayed until search fee is paid.

For International Bureau use only	
Date of receipt of the record copy by the International Bureau:	See Notes to the request form

Form PCT/RO/101 (last sheet) (July 1998; reprint January 2000)

The demand must be filed directly with the competent International Preliminary Examining Authority or, if two or more Authorities are competent, with the one chosen by the applicant. The full name or two-letter code of that Authority may be indicated by the applicant on the line below:

IPEA/ EPO

PCT

CHAPTER II

DEMAND

under Article 31 of the Patent Cooperation Treaty:
The undersigned requests that the international application specified below be the subject of international preliminary examination according to the Patent Cooperation Treaty and hereby elects all eligible States (except where otherwise indicated).

For International Preliminary Examining Authority use only		
Identification of IPEA		Date of receipt of DEMAND
Box No. I IDENTIFICATION OF THE INTERNATIONAL APPLICATION		Applicant's or agent's file reference 103140-5PCT
International application No. PCT/US00/10535	International filing date (day/month/year) 19 April 2000 (19.04.2000)	(Earliest) Priority date (day/month/year) 23 April 1999 (23.04.1999)
Title of invention WORKPIECE AUTHENTICATION BASED UPON ONE OR MORE WORKPIECE IMAGES		
Box No. II APPLICANT(S)		
Name and address: (Family name followed by given name; for a legal entity, full official designation. The address must include postal code and name of country.) THE ESCHER GROUP, LTD. 101 Main Street, 12th Floor Cambridge, Massachusetts 02142 United States of America		Telephone No.: Facsimile No.: Teleprinter No.:
State (that is, country) of nationality: US		State (that is, country) of residence: US
Name and address: (Family name followed by given name; for a legal entity, full official designation. The address must include postal code and name of country.) SMITH, JOSHUA R. 194 Norfolk Street Cambridge, Massachusetts 02139 United States of America		
State (that is, country) of nationality: US		State (that is, country) of residence: US
Name and address: (Family name followed by given name; for a legal entity, full official designation. The address must include postal code and name of country.) 		
State (that is, country) of nationality:		State (that is, country) of residence:
<input type="checkbox"/> Further applicants are indicated on a continuation sheet.		

Box No. III AGENT OR COMMON REPRESENTATIVE; OR ADDRESS FOR CORRESPONDENCEThe following person is ☒ agent ☐ common representativeand ☒ has been appointed earlier and represents the applicant(s) also for international preliminary examination.☐ is hereby appointed and any earlier appointment of (an) agent(s)/common representative is hereby revoked.☐ is hereby appointed, specifically for the procedure before the International Preliminary Examining Authority, in addition to the agent(s)/common representative appointed earlier.Name and address: *(Family name followed by given name; for a legal entity, full official designation.
The address must include postal code and name of country.)*GAGNE, Christopher K.
Cesari and McKenna, LLP
88 Black Falcon Avenue
Boston, Massachusetts 02210
United States of America

Telephone No.:

(617) 951-2500

Facsimile No.:

(617) 951-3927

Teleprinter No.:

☐ Address for correspondence: Mark this check-box where no agent or common representative is/has been appointed and the space above is used instead to indicate a special address to which correspondence should be sent.**Box No. IV BASIS FOR INTERNATIONAL PRELIMINARY EXAMINATION****Statement concerning amendments:***

1. The applicant wishes the international preliminary examination to start on the basis of:

☒ the international application as originally filedthe description ☒ as originally filed
☐ as amended under Article 34the claims ☒ as originally filed
☐ as amended under Article 19 (together with any accompanying statement)
☐ as amended under Article 34the drawings ☒ as originally filed
☐ as amended under Article 342. ☐ The applicant wishes any amendment to the claims under Article 19 to be considered as reversed.3. ☐ The applicant wishes the start of the international preliminary examination to be postponed until the expiration of 20 months from the priority date unless the International Preliminary Examining Authority receives a copy of any amendments made under Article 19 or a notice from the applicant that he does not wish to make such amendments (Rule 69.1(d)). *(This check-box may be marked only where the time limit under Article 19 has not yet expired.)*

* Where no check-box is marked, international preliminary examination will start on the basis of the international application as originally filed or, where a copy of amendments to the claims under Article 19 and/or amendments of the international application under Article 34 are received by the International Preliminary Examining Authority before it has begun to draw up a written opinion or the international preliminary examination report, as so amended.

Language for the purposes of international preliminary examination: English☒ which is the language in which the international application was filed.☐ which is the language of a translation furnished for the purposes of international search.☐ which is the language of publication of the international application.☐ which is the language of the translation (to be) furnished for the purposes of international preliminary examination.**Box No. V ELECTION OF STATES**The applicant hereby elects all eligible States *(that is, all States which have been designated and which are bound by Chapter II of the PCT)*

excluding the following States which the applicant wishes not to elect:

NONE

Box No. VI CHECK LIST

The demand is accompanied by the following elements, in the language referred to in Box No. IV, for the purposes of international preliminary examination:

- | | | |
|--|---|----------|
| 1. translation of international application | : | sheets |
| 2. amendments under Article 34 | : | sheets |
| 3. copy (or, where required, translation) of amendments under Article 19 | : | sheets |
| 4. copy (or, where required, translation) of statement under Article 19 | : | sheets |
| 5. letter | : | sheets |
| 6. other (<i>specify</i>) Transmittal Letter | : | 1 sheets |

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received not received

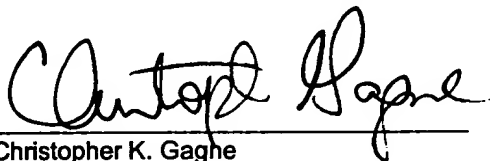
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<input type="checkbox"/>	<input type="checkbox"/>
<input type="checkbox"/>	<input type="checkbox"/>

The demand is also accompanied by the item(s) marked below:

- | | |
|--|---|
| 1. <input checked="" type="checkbox"/> fee calculation sheet | 4. <input type="checkbox"/> statement explaining lack of signature |
| 2. <input type="checkbox"/> separate signed power of attorney | 5. <input type="checkbox"/> nucleotide and or amino acid sequence listing in computer readable form |
| 3. <input type="checkbox"/> copy of general power of attorney; reference number, if any: | 6. <input type="checkbox"/> other (<i>specify</i>): |

Box No. VII SIGNATURE OF APPLICANT, AGENT OR COMMON REPRESENTATIVE

Next to each signature, indicate the name of the person signing and the capacity in which the person signs (if such capacity is not obvious from reading the demand).


Christopher K. Gaghe

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1. Date of actual receipt of DEMAND:

2. Adjusted date of receipt of demand due to CORRECTIONS under Rule 60.1(b):

3. ☐ The date of receipt of the demand is AFTER the expiration of 19 months from the priority date and item 4 or 5, below, does not apply.

☐ The applicant has been informed accordingly.

4. ☐ The date of receipt of the demand is WITHIN the period of 19 months from the priority date as extended by virtue of Rule 80.5.

5. ☐ Although the date of receipt of the demand is after the expiration of 19 months from the priority date, the delay in arrival is EXCUSED pursuant to Rule 82.

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Demand received from IPEA on:

09/719480

PATENT COOPERATION TREATY

14

PCT

REC'D 15 MAY 2001

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INTERNATIONAL PRELIMINARY EXAMINATION REPORT

(PCT Article 36 and Rule 70)



Applicant's or agent's file reference 103140-5PCT	FOR FURTHER ACTION See Notification of Transmittal of International Preliminary Examination Report (Form PCT/IPEA/416)	
International application No. PCT/US00/10535	International filing date (day/month/year) 19/04/2000	Priority date (day/month/year) 23/04/1999
International Patent Classification (IPC) or national classification and IPC G07B17/00		RECEIVED JUL 23 2001 Technology Center 2600
Applicant THE ESCHER GROUP, LTD		

1. This international preliminary examination report has been prepared by this International Preliminary Examining Authority and is transmitted to the applicant according to Article 36.
2. This REPORT consists of a total of 7 sheets, including this cover sheet.
 - ☐ This report is also accompanied by ANNEXES, i.e. sheets of the description, claims and/or drawings which have been amended and are the basis for this report and/or sheets containing rectifications made before this Authority (see Rule 70.16 and Section 607 of the Administrative Instructions under the PCT).

These annexes consist of a total of sheets.

3. This report contains indications relating to the following items:

- I ☒ Basis of the report
- II ☐ Priority
- III ☐ Non-establishment of opinion with regard to novelty, inventive step and industrial applicability
- IV ☐ Lack of unity of invention
- V ☒ Reasoned statement under Article 35(2) with regard to novelty, inventive step or industrial applicability; citations and explanations supporting such statement
- VI ☐ Certain documents cited
- VII ☒ Certain defects in the international application
- VIII ☒ Certain observations on the international application

Date of submission of the demand 26/10/2000	Date of completion of this report 11.05.2001
Name and mailing address of the international preliminary examining authority:  European Patent Office D-80298 Munich Tel. +49 89 2399 - 0 Tx: 523656 epmu d Fax: +49 89 2399 - 4465	Authorized officer Rahner, H-G Telephone No. +49 89 2399 2773 

**INTERNATIONAL PRELIMINARY
EXAMINATION REPORT**

International application No. PCT/US00/10535

I. Basis of the report

1. With regard to the **elements** of the international application (*Replacement sheets which have been furnished to the receiving Office in response to an invitation under Article 14 are referred to in this report as "originally filed" and are not annexed to this report since they do not contain amendments (Rules 70.16 and 70.17)*):

Description, pages:

1-25 as originally filed

Claims, No.:

1-83 as originally filed

Drawings, sheets:

1/7-7/7 as originally filed

2. With regard to the **language**, all the elements marked above were available or furnished to this Authority in the language in which the international application was filed, unless otherwise indicated under this item.

These elements were available or furnished to this Authority in the following language: , which is:

- ☐ the language of a translation furnished for the purposes of the international search (under Rule 23.1(b)).
☐ the language of publication of the international application (under Rule 48.3(b)).
☐ the language of a translation furnished for the purposes of international preliminary examination (under Rule 55.2 and/or 55.3).

3. With regard to any **nucleotide and/or amino acid sequence** disclosed in the international application, the international preliminary examination was carried out on the basis of the sequence listing:

- ☐ contained in the international application in written form.
☐ filed together with the international application in computer readable form.
☐ furnished subsequently to this Authority in written form.
☐ furnished subsequently to this Authority in computer readable form.
☐ The statement that the subsequently furnished written sequence listing does not go beyond the disclosure in the international application as filed has been furnished.
☐ The statement that the information recorded in computer readable form is identical to the written sequence listing has been furnished.

4. The amendments have resulted in the cancellation of:

- ☐ the description, pages:
☐ the claims, Nos.:

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**INTERNATIONAL PRELIMINARY
EXAMINATION REPORT**

International application No. PCT/US00/10535

☐ the drawings, sheets:

5. ☐ This report has been established as if (some of) the amendments had not been made, since they have been considered to go beyond the disclosure as filed (Rule 70.2(c)):

(Any replacement sheet containing such amendments must be referred to under item 1 and annexed to this report.)

6. Additional observations, if necessary:

V. Reasoned statement under Article 35(2) with regard to novelty, inventive step or industrial applicability; citations and explanations supporting such statement

1. Statement

Novelty (N)	Yes:	Claims	1-83
	No:	Claims	
Inventive step (IS)	Yes:	Claims	55,58,61,64,67,
	No:	Claims	1-54,56,57,59,60,62,63,65,66,68-83
Industrial applicability (IA)	Yes:	Claims	1-83
	No:	Claims	

2. Citations and explanations
see separate sheet

VII. Certain defects in the international application

The following defects in the form or contents of the international application have been noted:
see separate sheet

VIII. Certain observations on the international application

The following observations on the clarity of the claims, description, and drawings or on the question whether the claims are fully supported by the description, are made:
see separate sheet

Re Item V

Reasoned statement under Article 35(2) with regard to novelty, inventive step or industrial applicability; citations and explanations supporting such statement

1). Reference is made to the following documents:

D1: WO 97 24699 A (S E AXIS LIMITED; KARIAKIN YOURY D (BY)) 10 July 1997 (1997-07-10)

D2: SCHNEIDER M ET AL: 'ROBUST CONTENT BASED DIGITAL SIGNATURE FOR IMAGE AUTHENTICATION' PROCEEDINGS OF THE INTERNATIONAL CONFERENCE ON IMAGE PROCESSING (ICIP), US, NEW YORK, IEEE, 16 September 1996 (1996-09-16), pages 227-230, XP002090178 ISBN: 0-7803-3259-8

D3: EP-A-0 878 778 (PITNEY BOWES) 18 November 1998 (1998-11-18)

The document D1 is regarded as being the closest prior art to the subject-matter of claim 1, and discloses (the references in parentheses applying to this document):

An encrypted representation (3) of the topography of an area of an article (4) for placement on the article for use in determining whether the article is valid (see D1, claim 1), comprising:

a marking corresponding to at least a certifying signature (page 2, lines 17-24; page 21, lines 14-16) and a string, said signature being based at least in part upon said string wherein, if said article is valid, said string is based upon, at least in part, intrinsic physical characteristics (micro-topography) of at least one portion of said article, said physical characteristics including one or more images of surface topographical appearance of said at least one portion of said workpiece resulting when the at least one portion of said workpiece is illuminated with electromagnetic radiation from different illumination positions (see D1, claim 25) relative to said at least one portion.

The subject-matter of claim 1 therefore differs from this known arrangement in particular in that the signature is defined to come from a certifying authority CA. It is however generally known to the person skilled in the art that depending on circumstances the generation of a cryptographic digital signature has to meet specific security requirements (see the metering system in D3, column 5, lines 15-

38). It would be obvious to the person skilled in the art, namely when the same result is to be achieved, to apply this feature with corresponding effect to article authentication according to document D1, thereby arriving at a workpiece authentication technique according to claim 1. The subject-matter of independent claim 1 does therefore not involve an inventive step (Article 33(3) PCT).

- 2). Further independent claims 14, 28 and 42 relate to
- a method for generating a string for use in determining whether a workpiece is valid, to
 - an apparatus for use in generating a string for use in determining whether a workpiece is valid, and to
 - a computer-readable memory comprising computer-executable program instructions for use in generating a string for use in determining whether a workpiece is valid.

None of these independent claims defines a combination of features that goes beyond that of independent claim 1. The reasoning given with respect to claim therefore correspondingly applies to the subject-matter in claims 14, 28 and 42. These claims likewise do not meet the requirement of inventive step following from Article 33(3) PCT.

- 3). Dependent claims 1-26, 28-40, 42-54, 56, 57, 59, 60, 62, 63, 65, 66, 68-83 do not contain any features which, in combination with the features of any claim to which they refer, meet the requirements of the PCT in respect of novelty or inventive step for the following reasons:

claims 2,16,30,44

D1, Fig. 2, 8

claims 3-5,17-19,31-33,45-47

D3, abstract

claims 6,12,20,26,34,40,48,54

D2, page 228, paragraph 5.0

claims 7-10,21-24,35-38,49-52,

D1, p. 29, l. 13-35; p. 23, l. 9-24; claims 4,5,25,26;

56,57,59,60,62,63,65,66,68-83

D1, p. 2, l. 17-24

claims 15,29,43,

Re Item VII

Certain defects in the international application

- 4). From the PCT Guidelines II, 4.17 follows that where references to other documents in international applications relate directly to the disclosure of the invention, and if the matter in the document(s) referred to is essential to satisfy the requirements of Article 5, this matter should be incorporated in the description, because the patent specification should, regarding the essential features of the invention, be self-contained, i.e. capable of being understood without reference to any other document.

In case, the documents referred to are not essential in respect of Article 5, expressions as "...is incorporated into the subject application by reference" are to be deleted (e.g. on page 1, line 7; page 5, line 1; page 19, line 19; page 24, line 20).

- 5). The independent claims are not in the two-part form in accordance with Rule 6.3(b) PCT, which in the present case would be appropriate, with those features known in combination from the prior art (document D1) being placed in the preamble (Rule 6.3(b)(i) PCT) and with the remaining features being included in the characterising part (Rule 6.3(b)(ii) PCT).

The features of the claims are not provided with reference signs placed in parentheses (Rule 6.2(b) PCT).

Contrary to the requirements of Rule 5.1(a)(ii) PCT, the relevant background art disclosed in the documents D1 to D3 is not mentioned in the description, nor are these documents identified therein.

Re Item VIII

Certain observations on the international application

- 6). Present claims 27 and 41 contain the term "differences between the one or more images". It is not comprehensive in what way the first alternative option of said

**INTERNATIONAL PRELIMINARY
EXAMINATION REPORT - SEPARATE SHEET**

International application No. PCT/US00/10535

claims relating to "differences between one picture" shall be understood.

- 7). The requirement that the claims must be clear relates not only to claims individually but to the claims as a whole.

The fact, that

- claims appended to independent claims 1 (i.e. claims 56-58, 68, 72, 76-77),
- claims appended to independent claim 14 (i.e. claims 59-61, 69, 73, 78, 79),
- claims appended to independent claim 28 (i.e. claims 62-64, 70, 74, 80, 81),
- and claims appended to independent claim 42 (i.e. claims 65-67, 71, 82-83)

do not follow in the logical way the respective independent claim rather range a long way down and separated therefrom by other independent claims affects clarity of the claims as a whole (Article 6 PCT).

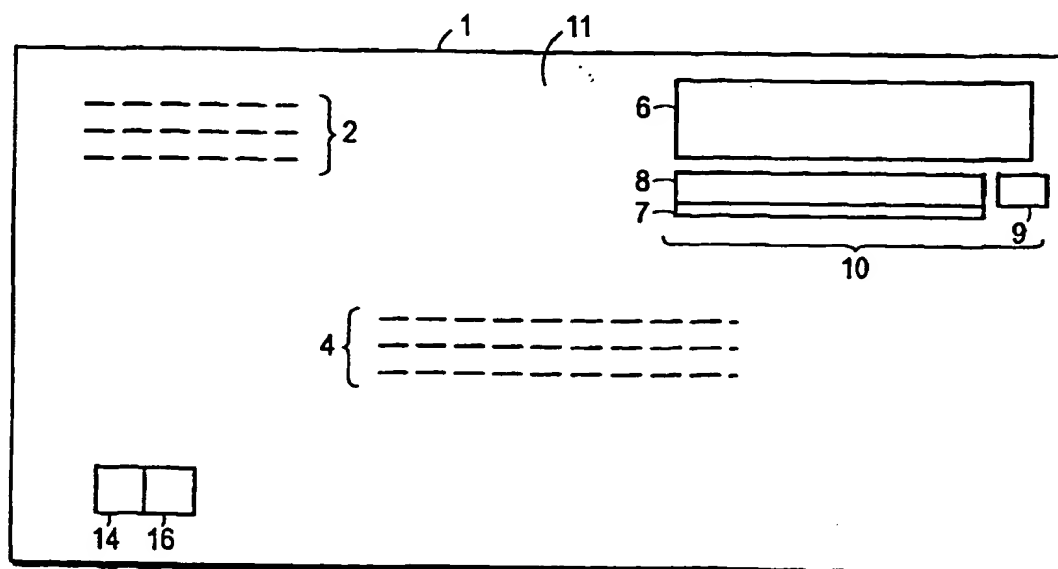
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INTERNATIONAL APPLICATION PUBLISHED UNDER THE PATENT COOPERATION TREATY (PCT)

(51) International Patent Classification ⁷ : G07B 17/00	A1	(11) International Publication Number: WO 00/65541 (43) International Publication Date: 2 November 2000 (02.11.00)
(21) International Application Number: PCT/US00/10535 (22) International Filing Date: 19 April 2000 (19.04.00) (30) Priority Data: 60/130,666 23 April 1999 (23.04.99) US (71) Applicant (for all designated States except US): THE ESCHER GROUP, LTD. [US/US]; 12th floor, 101 Main Street, Cambridge, MA 02142 (US). (72) Inventor; and (75) Inventor/Applicant (for US only): SMITH, Joshua, R. [US/US]; 194 Norfolk Street, Cambridge, MA 02139 (US). (74) Agents: GAGNE, Christopher, K. et al.; Cesari and McKenna, LLP, 88 Black Falcon Avenue, Boston, MA 02110 (US).		(81) Designated States: AE, AL, AM, AT, AU, AZ, BA, BB, BG, BR, BY, CA, CH, CN, CR, CU, CZ, DE, DK, DM, EE, ES, FI, GB, GD, GE, GH, GM, HR, HU, ID, IL, IN, IS, JP, KE, KG, KP, KR, KZ, LC, LK, LR, LS, LT, LU, LV, MA, MD, MG, MK, MN, MW, MX, NO, NZ, PL, PT, RO, RU, SD, SE, SG, SI, SK, SL, TJ, TM, TR, TT, TZ, UA, UG, US, UZ, VN, YU, ZA, ZW, ARIPO patent (GH, GM, KE, LS, MW, SD, SL, SZ, TZ, UG, ZW), Eurasian patent (AM, AZ, BY, KG, KZ, MD, RU, TJ, TM), European patent (AT, BE, CH, CY, DE, DK, ES, FI, FR, GB, GR, IE, IT, LU, MC, NL, PT, SE), OAPI patent (BF, BJ, CF, CG, CI, CM, GA, GN, GW, ML, MR, NE, SN, TD, TG). Published <i>With international search report.</i>

(54) Title: WORKPIECE AUTHENTICATION BASED UPON ONE OR MORE WORKPIECE IMAGES



(57) Abstract

A workpiece authentication technique is provided. The technique bases workpiece authentication upon intrinsic physical characteristics of the workpiece, including one or more images of topographical appearance of at least one portion of the workpiece.

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WORKPIECE AUTHENTICATION BASED UPON ONE OR MORE WORKPIECE IMAGES

CROSS-REFERENCE TO RELATED APPLICATIONS

The subject application claims the priority of copending U.S. Provisional Appli-
5 cation Serial No. 60/130,666, filed April 23, 1999, entitled "Authentication Techniques
Using Physical Uncopyability Primitive And Cryptographic Security." The entirety of
the disclosure of said copending application is hereby incorporated by reference into
the subject application. The subject application also is related to copending U.S. De-
sign Patent Application Serial No. 29/111,375, filed September 24, 1999, entitled "En-
10 velope With Postal Indicia And Related Items Having Unique Ornamental Appear-
ance."

BACKGROUND OF THE INVENTION

Field of the Invention

The present invention relates generally to workpiece authentication techniques,
15 and more specifically, to such techniques which involve imaging one or more portions
of the workpiece to generate abstractions (e.g., numeric or alphanumeric strings) which
represent random physical characteristics of the workpiece that may be used to deter-
mine whether the workpiece is authentic. Although the present invention will be de-
scribed in connection with authenticating postal mailpieces based upon such abstrac-
20 tions, it should be appreciated that the present invention has other utilities, including
authenticating workpieces other than postal mailpieces.

Brief Description of Related Prior Art

A value indicium is a symbol or token that indicates payment for a service. One example of a commonly-used value indicium is the "franking" or postal meter mark, which is placed on a postal mailpiece to indicate that a specified amount of money has
5 been paid to post the mailpiece. Other examples of value indicia include paper currency, money orders, and tickets for cultural events and transportation.

Authentication indicia are symbols or tokens placed on or in a workpiece for use in determining the validity of the workpiece (e.g., whether the workpiece is authentic, as opposed to being a forgery). For example, legal documents, such as passports
10 and driver's licenses often have validation stamps/seals from a certifying authority (CA), such as the government, placed on them that vouch for the authenticity of the legal documents.

In the past, if a postal franking mark on a postal mailpiece appeared to the ordinary observer (e.g., a postal clerk) to have been made by an authorized postal franking
15 device, the mailpiece would be considered valid and would be posted without further inquiry into whether the mark was genuine. Unfortunately, improvements in photocopying, computer-based imaging and duplication technologies have rendered this prior art authentication technique unreliable, as they have permitted the unscrupulous to produce high quality forgeries of such franking marks that often appear genuine to the ordinary observer. This has driven interest in creating a postal franking mark whose
20 authenticity can be determined without reference to its appearance, but instead can be determined using different criteria.

In one such conventional validation technique, the franking mark comprises an indicium that contains certain identifying information, such as the postage purchase date, meter identification number, franking sequence number, source and destination addresses of the mailpiece, and a cryptographic signature of the identifying information. According to this technique, mailpiece forgeries are detected based upon whether differences exist between the identifying information and the cryptographic signature in the indicium, and the actual identifying information of the mailpiece and the actual cryptographic signature of such actual identifying information.

Unfortunately, this latter validation technique is unable to thwart certain types of postal franking fraud. For example, if the identifying information and signature of a valid indicium of a first mailpiece are also valid for a second mailpiece, then the indicium of the first mailpiece may be fraudulently copied onto the second mail piece, and the fraudulent copying cannot be detected using this technique. Hereinafter, this type of fraud will be termed "double spending fraud."

Additionally, advances in networking technology have also permitted wide access to the data underlying such franking marks. For example, one could download such data using the Internet from a computer node storing such data (e.g., via email or a World Wide Web posting), and depending upon the manner in which this conventional technique is implemented, a large number of seemingly valid franking marks could be generated based upon such data. This further exacerbates the possibility and opportunity for such fraud.

In one prior art technique that is used to try to thwart double spending fraud, a database tracks use of value indicia and the respective identifying information therein.

If two mailpieces have identical indicia, the database indicates this as a possible occurrence of double spending fraud.

Unfortunately, in practical implementation, this conventional double spending fraud detection technique requires use of a large database to track the indicia's identifying information. Disadvantageously, the burden and expense of maintaining and querying such a large database is undesirable. Also disadvantageously, this conventional fraud detection technique does not permit off-line verification of the indicia (i.e., not based upon information obtained via a network), and no mechanism is provided in this technique to determine which indicium among indicia determined to be identical is authentic.

Another prior art fraud problem arises when unauthorized use is made of data or digital tokens (e.g., stored in a computerized postal franking system's internal memory) that when supplied to the system cause it to produce otherwise valid authentication indicia. This type of fraud will be termed hereinafter "meter tampering double spending fraud."

Other examples of prior art are disclosed in e.g., Melen, U.S. Patent No. 5,325,167 issued June 28, 1994; Daugman, U.S. Patent No. 5,291,560 issued March 1, 1994; Causse D'Agraves et al., U.S. Patent No. 4,677,435 issued June 30, 1997; Samyn, U.S. Patent No. 4,820,912 issued April 11, 1989; Goldman, U.S. Patent No. 4,423,415 issued December 27, 1983; Goldman, U.S. Patent No. 4,568,936 issued February 4, 1986; Brosow, U.S. Patent No. 4,218,674 issued August 19, 1980; Deneberg et al., U.S. Patent No. 5,521,984 issued May 28, 1996; Sansone, U.S. Patent No. 4,725,718, issued February 16, 1988; and Fougery et al., U.S. Patent No. 4,743,747,

issued May 10, 1988. Each of these patents is incorporated herein by reference in its entirety.

SUMMARY OF THE INVENTION

In accordance with the present invention, a workpiece authentication technique
5 is provided that overcomes the aforesaid and other disadvantages of the prior art. A first aspect of the present invention provides an authentication indicium, using this technique. In one embodiment of the indicium, the indicium is placed on a workpiece for use in determining the workpiece's validity. The indicium comprises a set of one or more markings that correspond to or represent a unique cryptographic signature from a
10 certifying authority (CA) and/or a numeric or alphanumeric string. The signature is based at least in part upon the string and a cryptographic key belonging to the CA. If the workpiece is valid, the string is based upon, at least in part, intrinsic physical characteristics of one or more portions of the workpiece. The physical characteristics include one or more images of surface topographical appearance of the one or more portions
15 of the workpiece that result when the one or more portions of the workpiece are illuminated with electromagnetic radiation from different illumination positions relative to these portions of the workpiece.

The one or more markings may comprise a barcode, sequence of digits, and/or a spread-spectrum marking. The workpiece may be a postal mailpiece. If the workpiece
20 is a valid postal mailpiece, the indicium may be printed on the mailpiece by an apparatus (e.g., a postal franking apparatus), and the string also may be representative of or comprise a postage value associated with the mailpiece (i.e., an amount of money paid to post the mailpiece) and/or an identification number used to identify the apparatus.

The string may also be based upon respective numerical values (e.g., representative of one or more hash values) representative of the unique physical characteristics, postage value, and/or apparatus identification number.

5 The different positions from which the workpiece is illuminated with electromagnetic radiation may be at respective, different oblique angles of elevation and the same azimuthal angle relative to the one or more portions of the workpiece. Advantageously, by illuminating the workpiece from such oblique angles of elevation, the physical characteristics may be made more easily discernable than would otherwise be the case. Alternatively, the different positions may be at respective, different azimuthal
10 angles and the same oblique angle of elevation relative to the one or more portions of the workpiece. The radiation with which the workpiece is illuminated may comprise coherent light. The one or more images may be generated from a portion of the illuminating radiation that is reflected from the one or more portions of the workpiece at an angle that is perpendicular to a surface of the workpiece.

15 The string may also be based upon, at least in part, a concatenation of a plurality of numerical hash values derived from the one or more images, or differences between or among such images. The one or more images may be generated by an imaging device having a radiation sensing element or elements that may consist of a linear array of photosensing elements, a two-dimensional array of photosensing elements, or a single
20 photo-sensing element. The imaging device may generate the images by scanning the one or more portions of the workpiece in accordance with imaging registration or fiducial marks on the workpiece. The photosensing element or elements of the imaging device may be integrated into or comprised within a mechanism for printing the indicium on the workpiece.

Apparatus and methods are also provided which implement aspects of the present invention. One embodiment of an apparatus according to a second aspect of the present invention is used to generate an indicium according to the present invention, and to place the generated indicium on a workpiece; an embodiment of an apparatus
5 according to a third aspect of the present invention is used to analyze a workpiece and an indicium already present on the workpiece to determine whether the workpiece is authentic.

In each of these embodiments of the apparatus according to the second and third aspects of the present invention, the apparatus generates a string for use in determining
10 whether the workpiece is valid. The apparatus includes an electromagnetic radiation source that illuminates one or more portions of the workpiece with electromagnetic radiation from different respective illumination positions relative to the one or more portions of the workpiece. An imaging device comprised in the apparatus generates respective images of surface topographical appearances of the one or more portions of the
15 workpiece, when the one or more portions of the workpiece are illuminated with the radiation. A string generating mechanism generates the string based upon, at least in part, the respective images generated by the imaging device.

Thus, in accordance with the present invention, determination of validity of the workpiece is based upon random, intrinsic physical characteristics of the workpiece,
20 thereby reducing or eliminating the need to perform database queries of identifying information to make such determinations. Advantageously, this permits the cost of preventing and/or thwarting the aforesaid types of fraud to be reduced compared to the prior art. Additionally, since significant effort is typically required to duplicate the intrinsic workpiece characteristics upon which determination of validity of the workpiece

is based, according to the present invention, this makes the perpetration of fraud more difficult and less likely to succeed compared to the prior art. Further advantageously, the technique of present invention permits off-line workpiece and indicia verification and also permits determination of which indicium, among identical indicia, is actually authentic.

These and other features and advantages of the present invention will become apparent as the following Detailed Description proceeds and upon reference to the Drawings, in which:

BRIEF DESCRIPTION OF THE DRAWINGS

Figure 1 is a highly schematic representation of the layout and elements comprised in a front surface of a mailpiece having one embodiment of an indicium in accordance with the first aspect of the present invention.

Figure 2 is a highly schematic representation of a portion of the mailpiece of Figure 1.

Figure 3 is a highly schematic representation of a variation of the portion of the workpiece shown in Figure 2.

Figure 4 is a highly schematic diagram illustrating the construction of one embodiment of an apparatus according to the second aspect of the present invention.

Figure 5 is a highly schematic diagram illustrating the construction of one embodiment of an apparatus according to the third aspect of the present invention.

Figures 6 and 7 are highly schematic diagrams illustrating positions of elements of the apparatus of Figures 4 and 5 relative to the mailpiece of Figure 1 when the apparatus are in use.

Although the following Detailed Description will proceed with reference being made to illustrative embodiments and methods of use, it will be appreciated by those skilled in the art that many alternatives, modifications, and variations thereof are possible without departing from the present invention. Thus, it is intended that the present invention should be viewed as encompassing all such alternatives, modifications, and variations as will be apparent to those skilled in the art, and should be defined only as set forth in the hereinafter appended claims.

DETAILED DESCRIPTION OF ILLUSTRATIVE EMBODIMENTS

With reference being made to Figures 1-7, illustrative embodiments of aspects of the present invention will now be described. Figures 1-2 illustrate features of a workpiece 1 that includes one embodiment of an authentication indicium 10 made according to one aspect of the present invention. More specifically, in Figures 1-2, workpiece 1 is a postal mailpiece that comprises a postal envelope whose front outer surface 11 includes indicium 10. Surface 11 also comprises written postal source address 2 (i.e., of the sender of mailpiece 1) and destination address 4 (i.e., of the intended recipient of mailpiece 1) in the upper left corner and center, respectively, of the surface 11 of mailpiece envelope 1. A postal symbol or artistic graphic 6 may also be placed on the surface 11 (e.g., in the upper right corner of surface 11 above the indicium 10, as shown in Figure 1).

In accordance with this embodiment of this aspect of the present invention, indicium 10 includes respective markings 7, 8 provided on surface 11 of the envelope 1. Markings 7 comprises a human-readable alphanumeric text disclosing to a human reader information that is pertinent to the mailpiece 1, such as, the amount of postage

that has been paid to post the mailpiece 1 and the city and/or country from which the mailpiece 1 is being posted. Markings 8 are a uni- or multi-dimensional bar code and/or sequence of human-readable digits that correspond to or represent a cryptographic signature, and/or a numeric or alphanumeric string. As will be described more
5 fully below, markings 8 of indicia 10 may be used, in accordance with aspects of the present invention, to determine validity of the workpiece 1.

As shown in Figure 2, markings 9 comprise a fiducial square or box 20 that encloses a portion 29 of the surface 11 of workpiece 1, and two fiducial points or dots 22, 24 therein adjacent respective, diagonally-opposite corners of box 20. Each of the dots
10 22, 24 is spaced away from a respective corner of the box 20 by a respective, identical distance.

Alternatively, as is shown in Figure 3, marking 9 may be replaced with markings 9'. Markings 9' include a fiducial square or box 20' that encloses a portion 29 of the surface 11 of workpiece 1, and three fiducial dots 22, 24, 25. The dots 22, 24, 25
15 are respectively located adjacent respective corners of the box 20'. More specifically, each of the dots 22, 24, 25 is spaced away from a respective corner of the box 20' by an identical, respective distance. Additionally, the distance between dots 22 and 25 is the same as the distance between dots 24 and 25, respectively.

As noted previously, markings 8 correspond to or are representative of a unique
20 cryptographic signature, and/or numeric or alphanumeric string. The signature may be the result of encrypting this string using one cryptographic key of a private/public cryptographic key pair of a CA (e.g., a governmental authority, such as the U.S. Postal Service) that can be used to determine validity of the string, using the other key from the key pair, using well known conventional private/public key encryption techniques.

As will be described more fully below, if the mailpiece is valid/authentic, the string being represented by or corresponding to the markings 8 is based upon, at least in part, certain random, intrinsic physical characteristics (symbolically referred to by numeral 26) of the portion 29. These physical characteristics 26 include respective images (referred to by numeral 47) of surface topographical appearances (symbolically referred to by numeral 27) of the portion 29 that result when portion 29 is illuminated with electromagnetic radiation R from respective different illumination positions 70, 72, 74 relative to portion 29 (see, Figures 4-7). That is, as will be described more fully below, the string represented by or corresponding to markings 8 is based upon or derived from respective images 47 of surface topographical appearances 27 of the portion 29 that result when portion 29 is illuminated with electromagnetic radiation R originating from respective positions 70, 72, 74 relative to the portion 29. As used herein, the term "image" may include any combination of one- and/or two-dimensional samplings of reflected radiation from the surface 11.

These surface topographical appearances 27 include details of certain microscopic phenomena that are random and result from intrinsic three dimensional properties of the surface 11 in portion 29. Such microscopic phenomena may include e.g., the appearances of and/or structures associated with mountains, craters, material configurations, and fiber configurations of the physical elements comprising portion 29.

The string comprises a numerical hash value that is computed using a predetermined hashing algorithm that operates upon numerical values representative of the images 47. Ideally, the algorithm should be selected such that it generates identical respective hash values when supplied with identical respective groups of images 47.

One example of such a hashing algorithm is the identity function. That is, images 47 may be converted into respective sets of numerical values (i.e., digitized), the sets of numerical values may be concatenated with each other, and the value of the resulting concatenation may serve as the hash value. In practice, however, it will usually
5 be desirable to employ a hashing algorithm that compresses (i.e., reduces the amount of data comprised in the sets of numerical values). For example, binary thresholded versions of the sets of numerical values may be concatenated to form the hash value, although typically much more compression will be desired. Alternatively, the sets of numerical values may be compressed with a lossy compression algorithm, such as
10 JPEG or wavelet compression, and concatenated. Also alternatively, in practice, a small number of coefficients from discrete cosine transforms, discrete Fourier transforms, or wavelet transforms of the sets of numerical values may be used to form the hash value.

Further alternatively, the hash value may be generated using an algorithm that
15 first extracts from the digitized images respective rectangular image portions of predetermined size (e.g., respective digitized image data corresponding to the respective image regions). These image regions may be 10 pixel rows by 200 pixel columns in size. Each of the image portions may then be scaled to a desired size, and undergo low pass filtering that permits verification using the ultimately-generated hash value to be less
20 sensitive to noise-related errors. This low pass filtering may comprise a transverse low pass filtering which is accomplished by averaging pixel illumination values in respective columns along respective columns of the respective scaled images, and using the average pixel illumination values generated as values for pixels in a resulting transversely low pass filtered image. More specifically, the respective average pixel values

are used as the respective values of pixels in the filtered image that correspond to the respective first pixel values in the respective columns used to generate the average pixel values. The averaged columns may each have the same size (e.g., 10 pixel values). Respective corresponding regions are then extracted from the transversely low pass filtered images (e.g., corresponding regions of 1 pixel by 100 pixels). These extracted regions then undergo a longitudinal high pass filtering. The high pass filtering may be accomplished by longitudinally low pass filtering the extracted regions and then subtracting corresponding pixel values of the longitudinally low pass filtered images from the respective, original extracted regions from which they were generated. The resulting high pass filtered images may then undergo binary thresholding, and the respective numerical values generated therefrom may be concatenated to form the hash value.

In order to decrease the size of the resulting hash value, and increase the discriminatory power of each bit of the hash value a majority of the pixels comprising the images 47 may be ignored when calculating the hash value. For example, the images may be broken down into groups of contiguous pixels (e.g., 5 contiguous pixels), and in each such pixel group, only a single corresponding pixel may be used in generating the hash value.

Additional techniques for generating the hash value include basing the hash value upon pairwise differences of corresponding pixel illumination values of pairs of images, sequential differences of these corresponding illumination values, and/or principle components representations of the images.

Figure 4 is a highly schematic diagram of one embodiment of an apparatus 30 for generating and placing marks 7, 8 of indicium 10 on surface 11 of envelope work-

piece 1. As shown in Figure 4, apparatus 30 includes controller 32. Controller 32 includes computer-readable memory 33 (e.g., comprising random access, read-only, and/or mass storage memory) for storing software programs and associated data structures for execution by one or more processors also comprised in controller 32 and/or other elements of apparatus 30. When executed by the one or more processors in apparatus 30, the software programs and data structures cause the controller 32 and other elements of apparatus 30 to carry out and/or implement the techniques, functions, and operations described herein as being carried out and/or implemented by controller 32 and other elements of apparatus 30. It will be apparent to those skilled in the art that many types of computer processors and memories may be used in controller 32 without departing from the present invention. For example, controller 32 may comprise one or more Intel 80X86-type processors and associated memory.

User input/output device 48 comprises a conventional mechanism for interfacing a human user (not shown) to the controller 32 so as to permit the user to control and monitor operation of apparatus 30. Device 48 may include, for example, one or more conventional computer-user interface devices, such as pointing and keyboard input devices, and a display output device which together permit the human user to input commands to controller 32 to be performed by apparatus 30, and to receive from controller 32 indication of receipt and progress of apparatus 30 in executing the input commands.

Apparatus 30 also includes a mechanism 38 for receiving the envelope 1 and for moving the envelope 1, once received, so as to position the envelope 1 relative to an electromagnetic radiation source 34 and imaging device 46 in such a way as to permit generation of images 47 by device 46. More specifically, mechanism 38 comprises conventional electromechanical components that permit the envelope 1 to be physically

inserted into mechanism 38, and thereafter, to be moved relative to source 34 and device 46, in the following manner.

After envelope 1 is physically inserted into mechanism 38, mechanism 38 signals controller 32 that envelope 1 has been received by mechanism 38. In response to this signal from mechanism 38, controller 32 activates registration sensor 40. Sensor 40 comprises conventional components for optically scanning the envelope surface 11 and for determining based upon such optical scanning the position and orientation of registration marks 9 relative to the source 34 and device 46. At periodic time intervals after its activation, sensor 40 provides to controller 32 information concerning the position and orientation of the marks 9 relative to the source 34 and device 46 from which controller 32 may determine the registration of the portion 29 relative to the source 34 and device 46. Controller 32 provides commands to mechanism 38 that cause mechanism 38 to move the envelope 1 relative to the source 34 and device 46 such that the source 34 and device 46 are brought into an initial predetermined registration relative to the portion 29.

In this initial registration, the source 34 is positioned at position 70 relative to the surface 11 of portion 29 in which an electromagnetic beam of illuminating radiation R may be emitted from the source 34 at an oblique elevation angle relative to the surface 11 of portion 29, and at an azimuthal angle of zero relative to the portion 29. Also, in this initial registration, the centroid of radiation sensing element(s) of the device 46 is positioned directly above the centroid of the portion 29. That is, device 46 comprises one or more radiation sensing elements that may include, e.g., a two-dimensional imaging camera, a linear array of photosensing elements (e.g., charge coupled devices) or a single such element. In this initial registration, if the device 46 comprises a two-

dimensional array of sensors, the centroid of the radiation sensing elements of device 46 is positioned directly above the centroid of the portion 29.

After the source 34 and device 46 are in this initial registration relative to the portion 29, the controller 32 causes the source 34 to emit a beam R of illuminating radiation which strikes the surface 11 of portion 29. A portion P of the radiation beam R is reflected from the surface 11 of portion 29 at an angle that is normal (i.e., perpendicular) to portion 29. This portion P of the radiation beam R is received by the sensing element(s) of device 46, which generate from portion P an image of the surface topographical appearance 27 of the portion 29. Device 46 then digitizes this image and supplies the digitized image to hash value generator 42. Generator 42 then stores the digitized image in a computer-readable memory (not shown), and indicates to controller 32 that it has received and stored the digitized image.

Controller 32 then causes mechanism 38 to change the registration of portion 29 relative to the source 34. In this changed registration, the source 34 is positioned in position 72, wherein yet another radiation beam R may be emitted from the source 34 at the oblique angle of elevation relative to the surface 11 of portion 29 and at an azimuthal angle of 90 degrees relative to the portion 29. In this changed registration, if the device 46 comprises a two-dimensional array of sensors, the centroid of the radiation sensing element(s) of the device 46 is positioned directly above the centroid of the portion 29, and the registration of the sensing element(s) relative to the portion 29 is unchanged from the initial registration.

Controller 32 then causes source 34 to emit another radiation beam R, which strikes portion 29 such that a portion P of the beam R is reflected from the surface 11 and is received by the device 46. Device 46 converts this portion P into another image

of the surface topographical appearance of the portion 29, and digitizes this image. The digitized image is then transmitted to the hash value generator 42, which stores the digitized image and indicates to the controller 32 that it has received and stored the digitized image.

5 Controller 32 then causes mechanism 38 to change the registration of portion 29 relative to the source 34. In this changed registration, the source 34 is positioned in position 74, wherein yet another radiation beam R may be emitted from the source 34 at the oblique angle of elevation relative to the surface 11 of portion 29 and at an azimuthal angle of 180 degrees relative to the portion 29. In this changed registration, the
10 centroid of the radiation sensing element(s) of the device 46 is positioned directly above the centroid of the portion 29, and the registration of the sensing element(s) relative to the portion 29 is unchanged from the initial registration. Controller 32 then causes source 34 to emit yet another beam of radiation R such that beam R strikes portion 29 and a portion P of the beam R is reflected from the surface 11 of portion 29 and
15 is received by the light sensing element(s) of device 46. Imaging device 46 converts this reflected portion P of radiation beam R into another image of the surface topographical features 27 of portion 29. This image is then digitized and transmitted to generator 42 which stores the image.

 After generator 42 has stored three images of respective surface topographical
20 appearances of portion 29 that resulted when source 34 illuminated portion 29 with radiation from three respective azimuthal angles relative to the portion 29 (i.e., corresponding to source positions 70, 72, and 74), generator 42 generates from the three images a hash value, using one of the previously described hash value generation algorithms. The hash value generated by generator 42 is then transmitted to controller 32.

Controller 32 then retrieves from the memory 33 a previously stored identification number that is used to identify the apparatus 30, and receives from the I/O device 48 a user-inputted postage value for the mailpiece 1. Controller 32 then concatenates the hash value with the apparatus identification number and the user-inputted postage value, in a predetermined fashion, so as to enable each of these values (i.e., the hash value, apparatus identification number, and postage value) to be extracted from the resultant concatenation when a predetermined extraction algorithm is applied to the resultant concatenation. Other values may also be so concatenated with the hash value (e.g., indicium version number, algorithm identification number, certificate and postal service device serial number, manufacturer identification number, apparatus model identification number, date of posting, ascending and descending register value, license post office zip code, apparatus software version identification number, destination delivery point code, and/or mail category/class code). The controller 32 then causes printing mechanism 36 to print markings 8 on surface 11 that correspond to or represent the resultant concatenation of the apparatus identification number, postage value, and hash value. The string once generated may be uploaded to the certifying authority 44 via network 45. The certifying authority 44 may then cryptographically sign the string provided to it by the controller 32 of apparatus 30, and may return the cryptographically signed string to the controller 32 via the network 45. Alternatively, if the controller 32 and memory 33 of apparatus 30 are tamper-resistant, the cryptographic key used to sign the string may be stored in memory 33. Controller 32 may then cause print mechanism 36 to print marks 8 onto surface 11 that correspond to or represent the cryptographically signed concatenation and decrement a maximum postage value stored in the tamper-resistant memory. Controller 32 may also cause printer 36 to place

marks 7 onto the surface 11 of the mailpiece 1; the information represented by the one or more marks 7 may be supplied to the controller 32 by a human user via device 48 and/or may be prestored in memory 33 and retrieved therefrom by controller 32. The information comprised in the string may be transmitted to the CA for storage in a database for use in ensuring that the purchaser of postage is properly charged for the postage being used to post the mailpiece 1, and for other purposes that will be described below. Alternatively, or in addition thereto, the user of apparatus 30 may be required to log onto network 45 and to provide via network 45 information necessary to ensure identity of the user and the postage value prior to receiving the signed string from the CA to ensure proper charging of the postage to the user.

As stated previously, markings 8 may comprise uni- or multi-dimensional barcodes and/or one or more human-readable sequences of digits. Alternatively, or in addition thereto, markings 8 may comprise one or more spread-spectrum markings wherein information from which the string, cryptographic signature of the string, and/or constituent portions thereof may be obtained, is "hidden", and retrievable therefrom in accordance with the teachings of copending U.S. Provisional Patent Application Serial No. 60/139,758, entitled "Information Hiding" filed June 15, 1999, and commonly owned with the subject application; the entirety of the disclosure of said copending application is incorporated into the subject application by reference.

Registration marks 9 may be placed on surface 11 by the manufacturer of the mailpiece 1 (i.e., prior to processing of the mailpiece 1 by apparatus 30). Alternatively, if appropriately modified, apparatus 30 may be configured to print the registration marks 9 at a predetermined location (i.e., the location that comprises portion 29) on surface 11, using printing mechanism 36. That is, the apparatus 30 may generate the im-

ages 47 and may then bring marks 9 so as to delimit the portion 29 of the workpiece 1 from which the images 47 were generated. Also alternatively, if apparatus 30 is appropriately modified, images 47 may be of topographical appearances of a plurality of different portions 14, 16, 29 of the envelope 1.

5 Depending upon the type of imaging device 46 used in apparatus 30, the device 46 may generate the images 47 by scanning the portion 29 in a direction from one predetermined registration dot (e.g., dot 22) to another dot (e.g., dot 24). Alternatively, if the device 46 comprises a linear array of photo-sensors or a single photosensing element, the device 46 may separately scan "strips" or contiguous two-dimensional re-
10 gions of the portion 29 and may generate respective composite images from which the hash value may be generated. Also, the illumination strength (i.e., amplitude) of the beam R may be adjusted so as to be equal to an empirically-determined "optimal" illumination strength (i.e., an illumination strength that provides an image with maximum contrast).

15 Figure 5 is a highly schematic diagram of an apparatus 41 for validating/authenticating a mailpiece purporting to have an indicium according to the first aspect of the present invention. It should be understood that, unless specifically stated to the contrary, the components and operation of like-numbered elements of apparatus 30 and 41 are substantially identical. Apparatus 41 generates the hash value by illuminat-
20 ing and imaging the mailpiece 1 in the same way as apparatus 30. Once generated by generator 42, the hash value is supplied to controller 32 of apparatus 41. Controller 32 of apparatus 41 stores the hash value from generator 42 in memory 33 of apparatus 41. Controller 32 then causes indicia reader 52 (e.g., comprising a conventional optical scanning system) to scan the marks 8 and to generate therefrom a digitized image of

marks 8 that is supplied to controller 32 of apparatus 41. Using conventional optical character and/or barcode recognition techniques, and/or the spread-spectrum information retrieval techniques from the aforesaid commonly-owned provisional application, the controller 32 generates from the digitized image from reader 52 the string and/or
5 cryptographic signature of the string corresponding to or represented by marks 8.

The controller 32 then may extract from the thus generated string the hash value, postage value, and apparatus identification number concatenated therein; controller 32 may then compare the extracted hash value with the hash value stored in memory 33 that was provided to controller 32 from generator 42 of apparatus 41. If the
10 two hash values match within a predefined tolerance, the controller 32 may output to a human operator via the device 48 an indication that the mailpiece 1 should be considered valid; if the two hash values do not match within a predefined tolerance, the controller 32 may provide the opposite indication to the operator or to automatic sorting equipment.

15 Alternatively, or in addition thereto, controller 32 of apparatus 41 may obtain from certifying authority 44 a cryptographic key that is expected to be able to verify the signature (i.e., the cryptographic key in the public/private key pair that is not the key that is expected to have been used to generate the cryptographic signature). The controller 32 of apparatus 41 may then use the retrieved cryptographic key to verify the
20 signature. If the digital signature of the string is valid, then the hash value contained in the string is compared with the hash value stored in memory 33 from the generator 42, and if the two hash values match within a predefined tolerance, the controller 32 of apparatus 41 provides to a human operator via device 48 an indication that the workpiece should be considered valid. If the two hash values do not match, however, an opposite

indication is provided by the controller 32 to the human user via device 48. The other information contained in the string (i.e., the postage value and apparatus identification number) may also be compared by the controller 32 with corresponding information known to be valid that is supplied to the controller 32 by the operator via device 48 of
5 apparatus 41.

For purposes of the hash value comparisons made by controller 32 of apparatus 41, each hash value being compared may be viewed as a feature vector, and each such comparison may be carried out in the following manner. After normalizing the feature vectors to be compared such that the length of the normalized vectors is unity, the fea-
10 ture vectors may be compared by obtaining an inner product measuring the cosine of the angle between the vectors in a high dimensional feature space. An inner product value that is within a predefined constant threshold for acceptance or rejection, e.g., approximately a constant multiple of unity divided by \sqrt{N} where N is the number di-
mensions of the feature space, may be defined to indicate that the vectors from which
15 the inner product value was generated are uncorrelated, and thus, that the respective underlying topographical features from which the vectors were created are most likely different from each other. An inner product value near +1 may be defined to indicate the converse. To overcome possible mis-registration, the two hash values may be com-
pared taking into account possible offsets, and the highest resulting inner product cor-
20 relation score may be used. Depending upon the device 46, the pixel brightness values of the digitized images from device 46 may consist of only positive values. This may cause these images to have large DC offsets (i.e., the zero spatial frequency component of the Fourier transforms of the images used to generate the hash values), which may make this inner product comparison technique inaccurate. In order to improve the ac-

curacy of this comparison technique, the DC offset of the images used to generate the compared hash values should be eliminated. Beyond eliminating the DC component, high pass filtering of the images (or appropriately selecting particular spatial frequency components thereof) generated by device 46 and thresholding the amplitude value associated therewith based upon an empirically determined threshold value (which may usually be zero) may help to improve the accuracy of this technique. Other hash value comparison techniques may alternatively be used by controller 32 of apparatus 41.

For example, depending upon the hash value algorithm employed, instead of comparing the two hash values, the hash value obtained from marks 8 may be parsed and decompressed to obtain images that may be compared directly with the images 47 generated by device 46 of apparatus 41 (i.e., for correlation therewith). Advantageously, this comparison technique may improve comparison consistency and accuracy.

Thus, it is evident that there has been provided in accordance with the present invention, a workpiece authentication technique that fully satisfies the aims and objectives, and achieves the advantages hereinbefore set forth. It will be apparent to those skilled in the art that many alternatives, modifications, and variations of the foregoing illustrative embodiments are possible without departing from the present invention. For example, although the source 34 has been described as moving relative to the portion 29 such that source 34 is positioned at different azimuthal angles, but the same angle of elevation, relative to portion 29, if apparatus 30, 41 are appropriately modified, source 34 may instead move relative to portion 29 such that source 34 is positioned at different angles of elevation, but the same azimuthal angle, relative to the portion 29. Images 47

may be generated when radiation R is emitted from the source 34 when source 34 is in these different elevational angles. Other modifications are also possible.

For example, the source 34 may include multiple light source and/or fiberoptic light emission systems positioned at multiple orientation relative to the workpiece.

5 These systems may be sequentially activated, or alternatively, may be activated simultaneously to provide illumination to the portion 29 from multiple angles/orientations/positions relative to the portion 29 simultaneously.

Also, apparatus 30 may be modified such that controller 32 may cause printer 36 to print on surface 11 markings representative of or corresponding to the hash value
10 generated by generator 42. Such markings may comprise human-readable optical character recognizable sequences of digits, uni- or multi-dimensional barcodes, and/or spread-spectrum markings within which information from which the hash value may be obtained is hidden. Alternatively, the hash value may be provided to an end user from the manufacturer of the envelope via a mass storage memory device (e.g., floppy or
15 optical disc encoded to store the hash value), electronic messages sent to the end user via a communications network, or via interaction with an object identification tag system wherein the hash value is stored (e.g., of the type disclosed in copending U.S. provisional patent application Serial No. 60/155,495, filed September 23, 1999, entitled "Object Identification Tagging"; this copending application is commonly owned with
20 the subject application and is incorporated herein by reference in its entirety. The end user may then request that the CA sign the hash value (or a concatenation of the hash value with other information, such as a user identification number and postage value) using a cryptographic key of the end user or of the certifying authority 44, and marks representative of or corresponding to the resulting signature may be placed onto surface

11 as marks 8 by a conventional printing system. Advantageously, the end user in this alternative arrangement need not employ an imaging device 46 and source 34 to generate the string and cryptographic signature. This may substantially reduce the cost and simplify the construction of the system used by the end user to generate marks 8. Also
5 advantageously in this alternative, envelopes may be fabricated without preprinted postage values and valid postage may be obtained by the end user.

Additional modifications are also possible. For example, the device 46 may be integrated or comprised in printing mechanism 36 of apparatus 30. Alternatively, the device 46 may comprise a standalone type of imaging device (e.g., digital camera,
10 scanner, etc.) Also, the registration sensor 40 may be comprised or integrated in the imaging device 46.

Further, if appropriately modified, the functionality of apparatus 30 and 41 may be combined and one imaging device 46 may be used both to generate images 47 and to scan the marks 8. Additionally, the apparatus 30 and 41, or functional components
15 thereof, may be comprised in postal mailpiece sorting apparatus. Accordingly, the present invention is intended to be viewed quite broadly, as encompassing all such alternatives, modifications, and variations as may be apparent to those skilled in the art, and as being defined only as forth in the appended claims.

What is claimed is:

CLAIMS

- 1 1. An indicium for placement on a workpiece for use in determining
2 whether the workpiece is valid, comprising:
3 a set of one or more markings corresponding to at least one of a signature from
4 a certifying authority (CA) and a string, said signature being based at least in part upon
5 said string wherein, if said workpiece is valid, said string is based upon, at least in part,
6 intrinsic physical characteristics of at least one portion of said workpiece, said physical
7 characteristics including one or more images of surface topographical appearance of
8 said at least one portion of said workpiece resulting when the at least one portion of
9 said workpiece is illuminated with electromagnetic radiation from different illumina-
10 tion positions relative to said at least one portion.
- 1 2. An indicium according to claim 1, wherein said one or more markings
2 comprise at least one of the following on said workpiece: a barcode, a sequence of dig-
3 its, and a spread-spectrum marking.
- 1 3. An indicium according to claim 1, wherein said workpiece comprises a
2 postal mailpiece.
- 1 4. An indicium according to claim 1, wherein said workpiece comprises a
2 postal mailpiece, and said string is also representative of a postage value associated
3 with said mailpiece, if said workpiece is valid.

1 5. An indicium according to claim 4, wherein said indicium is imprinted on
2 said mailpiece by an apparatus, and said string also identifies the apparatus, if said
3 workpiece is valid.

1 6. An indicium according to claim 5, wherein said string is based upon re-
2 spective numerical values representative of: one or more hash values representative of
3 said characteristics, said postage value, and an identification value identifying said ap-
4 paratus.

1 7. An indicium according to claim 1, wherein the different positions are at
2 respective different oblique angles, and an identical azimuthal angle, relative to the at
3 least one portion of the workpiece.

1 8. An indicium according to claim 1, wherein the different positions are at
2 respective different azimuthal angles, and an identical oblique angle, relative to the at
3 least one portion of the workpiece.

1 9. An indicium according to claim 1, wherein a portion of the radiation is
2 reflected from the at least one portion at an angle that is normal to a surface of the at
3 least one portion, and the one or more images are generated from said portion of the
4 radiation.

1 10. An indicium according to claim 1, wherein the radiation comprises co-
2 herent light.

1 11. An indicium according to claim 1, wherein the at least one portion com-
2 prises a plurality of portions of the workpiece.

1 12. An indicium according to claim 1, wherein said string is based upon, at
2 least in part, a concatenation of a plurality of numerical hash values derived from said
3 one or more images.

1 13. An indicium according to claim 1, wherein said string is based upon, at
2 least in part, differences between the one or more images.

1 14. Apparatus for use in generating a string for use in determining whether a
2 workpiece is valid, comprising:
3 an electromagnetic radiation source for illuminating at least one portion of the
4 workpiece with electromagnetic radiation from different illumination positions relative
5 to said at least one portion;
6 an imaging device for generating one or more images of surface topographical
7 appearance of said at least one portion when the at least one portion is illuminated with
8 the radiation by the source at the different illumination positions; and
9 a string generator that generates the string based upon, at least in part, the one or
10 more images.

1 15. Apparatus according to claim 14, further comprising a mechanism that
2 marks the workpiece with a set of one or more markings corresponding to at least one

3 of a signature from a certifying authority (CA) and the string, the signature being based
4 upon the string and a cryptographic key of the CA.

1 16. Apparatus according to claim 15, wherein said one or more markings
2 comprise at least one of the following on said workpiece: a barcode, a sequence of dig-
3 its, and a spread-spectrum marking.

1 17. Apparatus according to claim 15, wherein said workpiece comprises a
2 postal mailpiece.

1 18. Apparatus according to claim 15, wherein said workpiece comprises
2 postal mailpiece, and said string is also representative of a postage value associated
3 with said mailpiece, if said workpiece is valid.

1 19. Apparatus according to claim 18, wherein said one or more markings are
2 imprinted on said mailpiece, and said string is also identifies the apparatus, if said
3 workpiece is valid.

1 20. Apparatus according to claim 19, wherein said string is based upon re-
2 spective numerical values representative of: one or more hash values representative of
3 said appearance, said postage value, and an identification value identifying said appa-
4 ratus.

1 21. Apparatus according to claim 14, wherein the different positions are at
2 respective different oblique angles, and an identical azimuthal angle, relative to the at
3 least one portion of the workpiece.

1 22. Apparatus according to claim 14, wherein the different positions are at
2 respective different azimuthal angles, and an identical oblique angle, relative to the at
3 least one portion of the workpiece.

1 23. Apparatus according to claim 14, wherein a portion of the radiation is
2 reflected from the at least one portion at an angle that is normal to a surface of the at
3 least one portion, and the one or more images are generated from said portion of the
4 radiation.

1 24. Apparatus according to claim 14, wherein the radiation comprises co-
2 herent light.

1 25. Apparatus according to claim 14, wherein the at least one portion com-
2 prises a plurality of portions of the workpiece.

1 26. Apparatus according to claim 14, wherein said string is based upon, at
2 least in part, a concatenation of a plurality of numerical hash values derived from said
3 one or more images.

1 27. Apparatus according to claim 14, wherein said string is based upon, at
2 least in part, differences between the one or more images.

1 28. Method for generating a string for use in determining whether a work-
2 piece is valid, comprising:
3 illuminating at least one portion of the workpiece with electromagnetic radiation
4 from different illumination positions relative to said at least one portion;
5 generating one or more images of surface topographical appearance of said at
6 least one portion when the at least one portion is illuminated with the radiation at the
7 different illumination positions; and
8 generating the string based upon, at least in part, the one or more images.

1 29. Method according to claim 28, further comprising marking the work-
2 piece with a set of one or more markings corresponding to at least one of a signature
3 from a certifying authority (CA) and the string, the signature being based upon the
4 string and a cryptographic key of the CA.

1 30. Method according to claim 29, wherein said one or more markings com-
2 prise at least one of the following on said workpiece: a barcode, a sequence of digits,
3 and a spread-spectrum marking.

1 31. Method according to claim 28, wherein said workpiece comprises a
2 postal mailpiece.

1 32. Method according to claim 29, wherein said workpiece comprises a
2 postal mailpiece, and said string is also representative of a postage value associated
3 with said mailpiece, if said workpiece is valid.

1 33. Method according to claim 32, wherein said one or more markings are
2 imprinted on said mailpiece by an apparatus, and said string also identifies the appara-
3 tus, if said workpiece is valid.

1 34. Method according to claim 33, wherein said string is based upon respec-
2 tive numerical values representative of: one or more hash values representative of said
3 appearance, said postage value, and an identification value identifying said apparatus.

1 35. Method according to claim 28, wherein the different positions are at dif-
2 ferent oblique angles, and an identical azimuthal angle, relative to the at least one por-
3 tion of the workpiece.

1 36. Method according to claim 28, wherein the different positions are at re-
2 spective different azimuthal angles, and an identical oblique angle, relative to the at
3 least one portion of the workpiece.

1 37. Method according to claim 28, wherein a portion of the radiation is re-
2 flected from the at least one portion at an angle that is normal to a surface of the at least
3 one portion, and the one or more images are generated from said portion of the radia-
4 tion.

1 38. Method according to claim 28, wherein the radiation comprises coherent
2 light.

1 39. Method according to claim 28, wherein the at least one portion com-
2 prises a plurality of portions of the workpiece.

1 40. Method according to claim 28, wherein said string is based upon, at least
2 in part, a concatenation of a plurality of numerical hash values derived from said one or
3 more images.

1 41. Method according to claim 28, wherein said string is based upon, at least
2 in part, differences between the one or more images.

1 42. Computer-readable memory comprising computer-executable program
2 instructions for use in generating a string for use in determining whether a workpiece is
3 valid, the instructions when executed causing:

4 illumination of at least one portion of the workpiece with electromagnetic ra-
5 diation from different illumination positions relative to said at least one portion;

6 generation of one or more images of surface topographical appearance of said at
7 least one portion when the at least one portion is illuminated with the radiation at the
8 different illumination positions; and

9 generation of the string based upon, at least in part, the one or more images.

1 43. Memory according to claim 42, wherein the instructions when executed
2 also cause marking of the workpiece with a set of one or more markings corresponding
3 to at least one of a signature from a certifying authority (CA) and the string, the signa-
4 ture being based upon the string and a cryptographic key of the CA.

1 44. Memory according to claim 43, wherein said one or more markings
2 comprise at least one of the following on said workpiece: a barcode, a sequence of dig-
3 its, and a spread-spectrum marking.

1 45. Memory according to claim 42, wherein said workpiece comprises a
2 postal mailpiece.

1 46. Memory according to claim 43, wherein said workpiece comprises a
2 postal mailpiece, and said string is also representative of a postage value associated
3 with said mailpiece, if said workpiece is valid.

1 47. Memory according to claim 46, wherein said one or more markings are
2 imprinted on said mailpiece by an apparatus, and said string also identifies the appa-
3 tus, if said workpiece is valid.

1 48. Memory according to claim 47, wherein said string is based upon re-
2 spective numerical values representative of: one or more hash values representative of
3 said appearance, said postage value, and an identification value identifying said appa-
4 ratus.

1 49. Memory according to claim 42, wherein the different positions are at re-
2 spective different oblique angles, and an identical azimuthal angle, relative to the at
3 least one portion of the workpiece.

1 50. Memory according to claim 42, wherein the different positions are at re-
2 spective different azimuthal angles, and an identical oblique angle, relative to the at
3 least one portion of the workpiece.

1 51. Memory according to claim 42, wherein a portion of the radiation is re-
2 flected from the at least one portion at an angle that is normal to a surface of the at least
3 one portion, and the one or more images are generated from said portion of the radia-
4 tion.

1 52. Memory according to claim 42, wherein the radiation comprises coher-
2 ent light.

1 53. Memory according to claim 42, wherein the at least one portion com-
2 prises a plurality of portions of the workpiece.

1 54. Memory according to claim 42, wherein said string is based upon, at
2 least in part, a concatenation of a plurality of numerical hash values derived from said
3 images.

1 55. Memory according to claim 42, wherein said string is based upon, at
2 least in part, differences between the images.

1 56. An indicium according to claim 1, wherein the at least one portion is il-
2 luminated with the radiation simultaneously from the different illumination positions.

1 57. An indicium according to claim 1, wherein the one or more images
2 comprise a plurality of respective images of surface topographical appearances of the at
3 least one portion resulting when the at least one portion is illuminated with the radiation
4 from respective illumination positions relative to the at least one portion.

1 58. An indicium according to claim 1, wherein the string is based upon, at
2 least in part, a numerical hash value derived from the one or more images, the value
3 being generated by a process that includes extracting from the one or more images a
4 first image portion scaling the first image portion to generate a scaled image portion,
5 averaging pixel value of the scaled image portion to generate a first filtered image, ex-
6 tracting from the first filtered image a second image portion, averaging pixel values of
7 the second image portion to generate a second filtered image, and subtracting corre-
8 sponding pixel value of the second filtered image from the second image portion to
9 generate a third filtered image.

1 59. Apparatus according to claim 14, wherein the at least one portion is il-
2 luminated with the radiation simultaneously from the different illumination positions.

1 60. Apparatus according to claim 14, wherein the images of surface topog-
2 raphical appearances of the at least one portion resulting when the at least one portion
3 is illuminated with the radiation from respective illumination positions relative to the at
4 least one portion.

1 61. Apparatus according to claim 14, wherein the string is based upon, at
2 least in part, a numerical hash value derived from the one or more images, the value
3 being generated by a process that includes extracting from the one or more images a
4 first image portion, scaling the first image portion to generate a scaled image portion,
5 averaging pixel values of the scaled image portion to generate a first filtered image,
6 extracting from the first filtered image a second image portion, averaging pixel values
7 of the second image portion to generate a second filtered image, and subtracting corre-
8 sponding pixel values of the second filtered image from the second image portion to
9 generate a third filtered image.

1 62. Method according to claim 28, wherein the at least one portion is illumi-
2 nated with the radiation simultaneously from the different illumination positions.

1 63. Method according to claim 28, wherein the one or more images com-
2 prise a plurality of respective images of surface topographical appearances of the at
3 least one portion resulting when the at least one portion is illuminated with the radiation
4 from respective illumination positions relative to the at least one portion.

1 64. Method according to claim 28, wherein the sting is based upon, at least
2 in part, a numerical hash value derived from the one or more images, the value being
3 generated by a process that includes extracting from the one or more images a first im-
4 age portion, scaling the first image portion to generate a scaled image portion, averag-
5 ing pixel values of the scaled image portion to generate a first filtered image, extracting
6 from the first filtered image a second image portion, averaging pixel values of the sec-
7 ond image portion to generate a second filtered image, and subtracting corresponding
8 pixel values of the second filtered image from the second image portion to generate a
9 third filtered image.

1 65. Memory according to claim 42, wherein at least one portion is illumi-
2 nated with the radiation simultaneously from the different illumination positions.

1 66. Memory according to claim 42, wherein the one or more images com-
2 prise a plurality of respective images of surface topographical appearances of the at
3 least one portion resulting when the at least one portion is illuminated with the radiation
4 from respective illumination positions relative to the at least one portion.

1 67. Memory according to claim 42, wherein the string is based upon, at least
2 in part, a numerical hash value derived from the one or more images, the value being
3 generated by a process that includes extracting from the one or more images a first im-
4 age portion, scaling the first image portion to generate a scaled image portion, averag-
5 ing pixel values of the scaled image portion to generate a first filtered image, extracting
6 from the first filtered image a second page portion, averaging pixel values of the second

7 image portion to generate a second filtered image, and subtracting corresponding pixel
8 values of the second filtered image from the second image portion to generate a third
9 filtered image.

1 68. An indicium according to claim 1, wherein the one or more images are
2 generated using one of a linear array of photosensing elements, a two-dimensional ar-
3 ray of photosensing elements and a single photosensing element.

1 69. Apparatus according to claim 14, wherein the imaging device comprises
2 one of a linear array of photosensing elements, a two-dimensional array of photo-
3 sensing elements and a single photosensing element.

1 70. Method according to claim 28, wherein the one or more images are gen-
2 erated using one of a linear array of photosensing elements, a two-dimensional array of
3 photosensing elements and a single photosensing element.

1 71. Memory according to claim 42, wherein the one or more images are
2 generated using one of a linear array of photosensing elements, a two-dimensional ar-
3 ray of photosensing elements and a single photosensing element.

1 72. An indicium according to claim 1, wherein the indicium uniquely identi-
2 fies the workpiece.

1 73. Apparatus according to claim 14, wherein the string uniquely identifies
2 the workpiece.

1 74. Method according to claim 28, wherein the string uniquely identifies the
2 workpiece.

1 75. Memory according to claim 42, wherein the string uniquely identifies
2 the workpiece.

1 76. An indicium according to claim 1, wherein the string is based, at least in
2 part, upon an averaging of portions of the one or more images.

1 77. An inidicum according to claim 1, wherein the string is based, at least in
2 part, upon a calculation of principal components of the one or more images.

1 78. Apparatus according to claim 14, wherein the string is based, at least in
2 part, upon an averaging of portions of the one or more images.

1 79. Apparatus according to claim 14, wherein the string is based, at least in
2 part, upon a calculation of principal components of the one or more images.

1 80. Method according to claim 28, wherein the string is based, at least in
2 part, upon an averaging of portions of the one or more images.

1 81. Method according to claim 28, wherein the string is based, at least in
2 part, upon a calculation of principal components of the one or more images.

1 82. Memory according to claim 42, wherein the string is based, at least in
2 part, upon an averaging of portions of the one or more images.

1 83. Memory according to claim 42, wherein the string is based, at least in
2 part, upon a calculation of principal components of the one or more images.

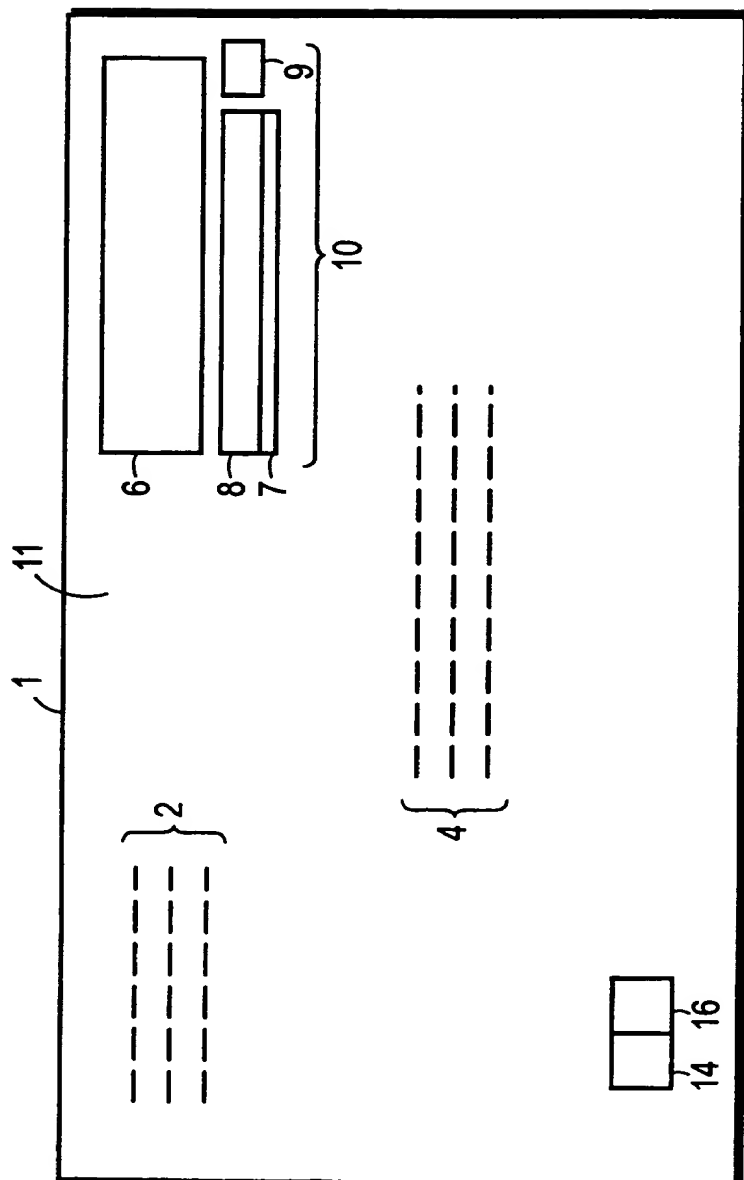


FIG. 1

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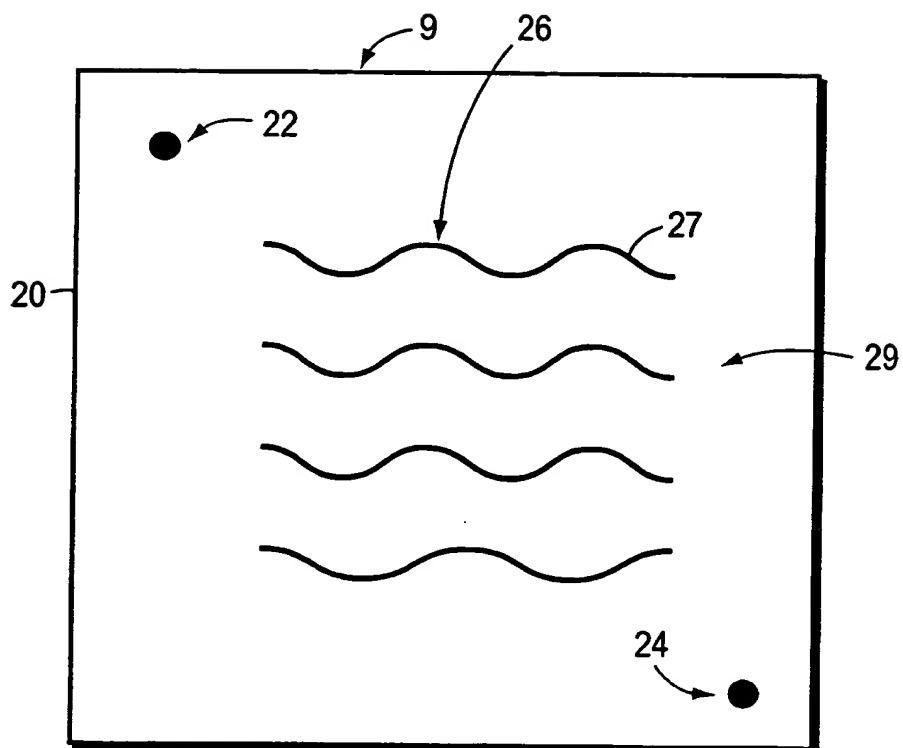


FIG. 2

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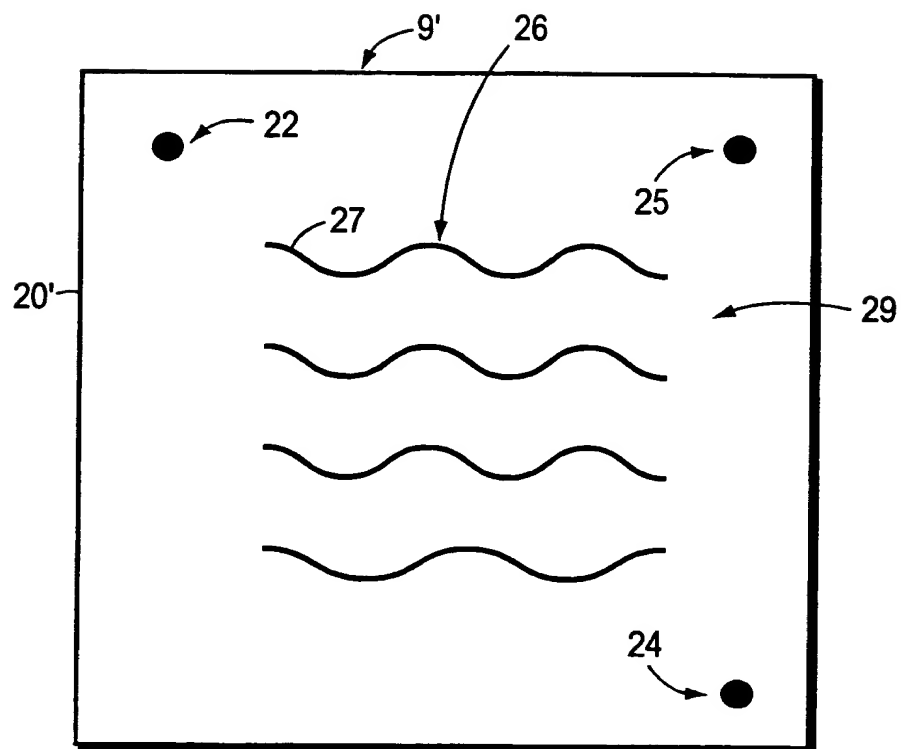


FIG. 3

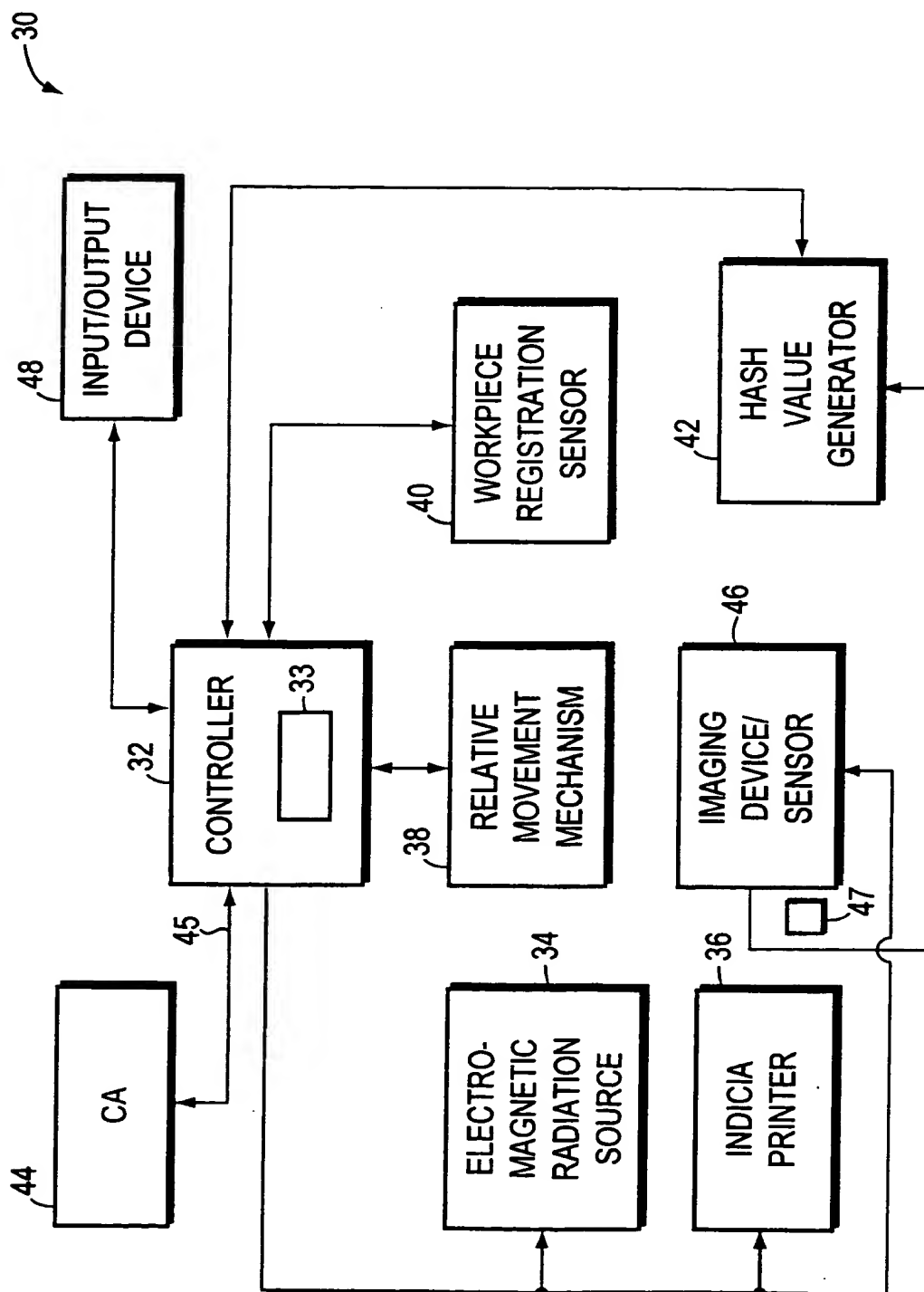


FIG. 4

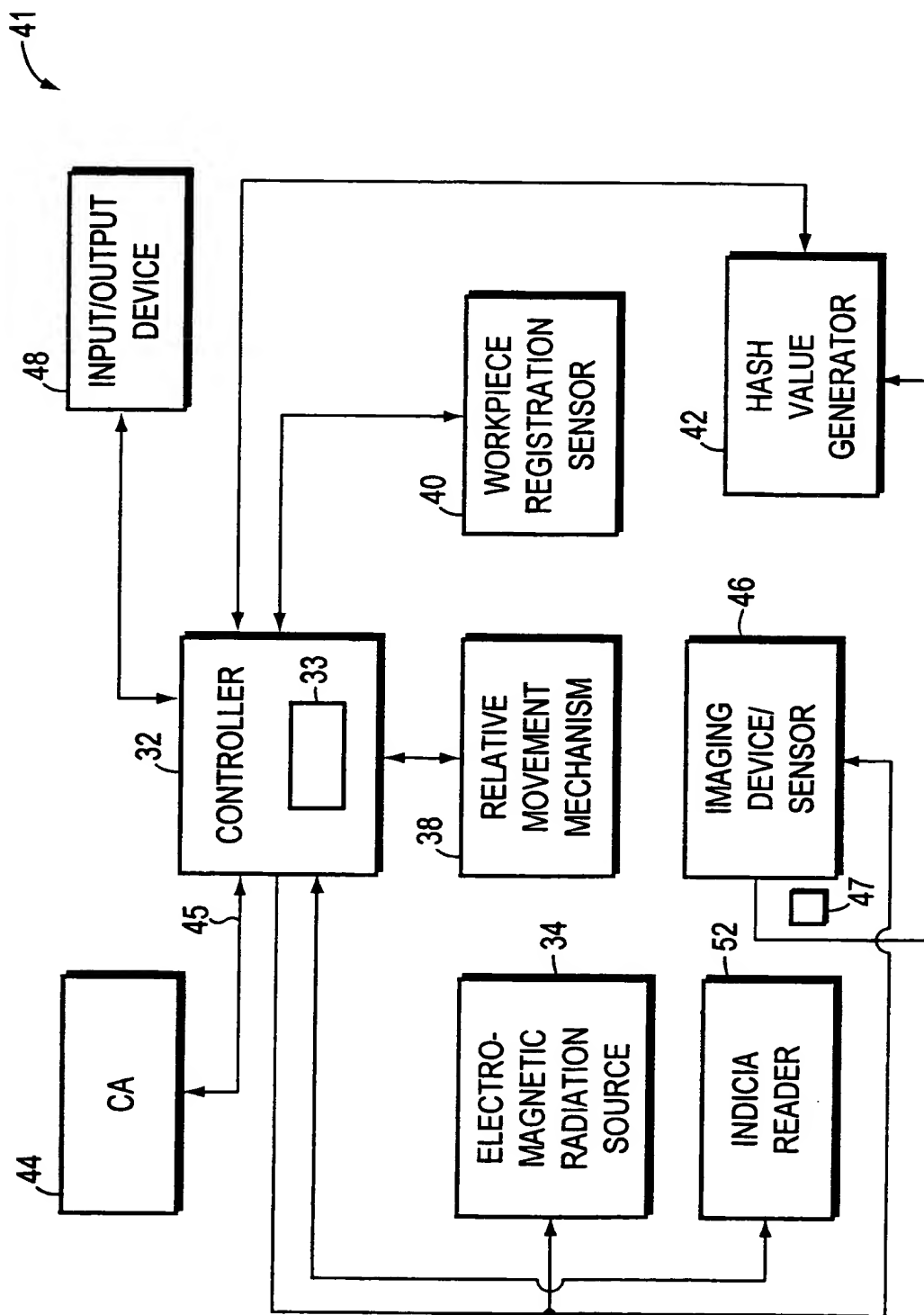


FIG. 5

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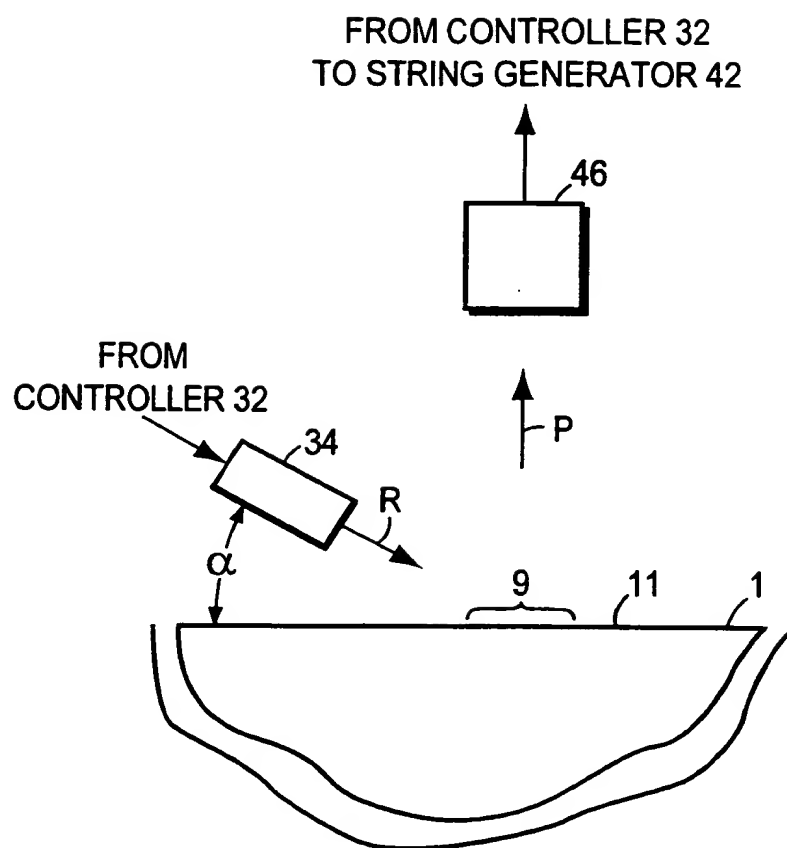


FIG. 6

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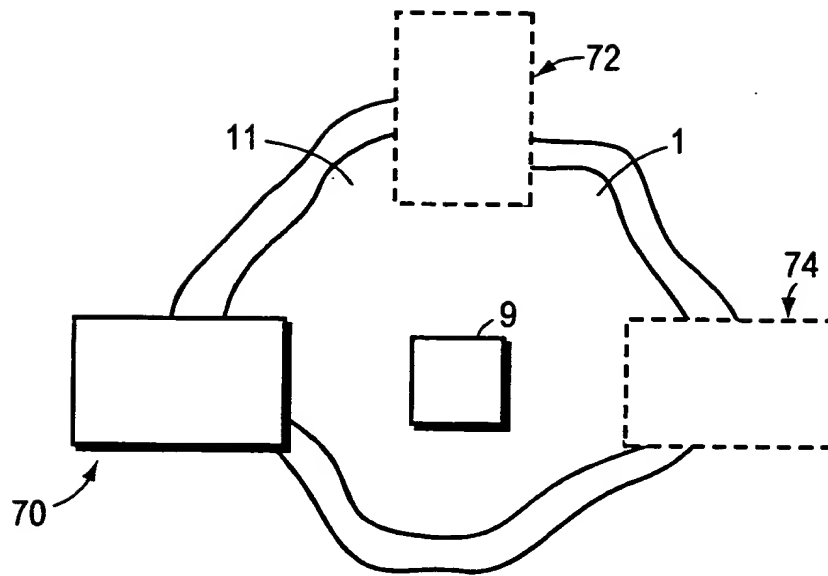


FIG. 7

INTERNATIONAL SEARCH REPORT

Int .tional Application No

PCT/US 00/10535

A. CLASSIFICATION OF SUBJECT MATTER
IPC 7 G07B17/00

According to International Patent Classification (IPC) or to both national classification and IPC

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)

IPC 7 G07B

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched

Electronic data base consulted during the international search (name of data base and, where practical, search terms used)

EPO-Internal, WPI Data, PAJ

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category *	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
A	WO 97 24699 A (S E AXIS LIMITED ;KARIAKIN YOURY D (BY)) 10 July 1997 (1997-07-10) claims 1,2; figures 8,9 ---	1-83
A	WO 96 30878 A (FIRSKIN SERGEI GENNADIEVICH ;ROGOZHINSKY JURY ALEXANDROVICH (BY);) 3 October 1996 (1996-10-03) figure 1 --- -/--	1-83

☒ Further documents are listed in the continuation of box C.

☒ Patent family members are listed in annex.

* Special categories of cited documents :

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Date of the actual completion of the international search

17 July 2000

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25/07/2000

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INTERNATIONAL SEARCH REPORT

Int. Application No

PCT/US 00/10535

C.(Continuation) DOCUMENTS CONSIDERED TO BE RELEVANT

Category	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
A	SCHNEIDER M ET AL: "ROBUST CONTENT BASED DIGITAL SIGNATURE FOR IMAGE AUTHENTICATION" PROCEEDINGS OF THE INTERNATIONAL CONFERENCE ON IMAGE PROCESSING (ICIP),US,NEW YORK, IEEE, 16 September 1996 (1996-09-16), pages 227-230, XP002090178 ISBN: 0-7803-3259-8 figure 2 ----	1-83
A	EP 0 878 778 A (PITNEY BOWES) 18 November 1998 (1998-11-18) claim 1; figure 4 ----	1-83
A	US 5 098 130 A (MIKHAIL AMEER G) 24 March 1992 (1992-03-24) claim 1; figure 25 -----	1-83

INTERNATIONAL SEARCH REPORT

Information on patent family members

In ternational Application No

PCT/US 00/10535

Patent document cited in search report	Publication date	Patent family member(s)	Publication date
WO 9724699 A	10-07-1997	AU 4311896 A	28-07-1997
WO 9630878 A	03-10-1996	NONE	
EP 0878778 A	18-11-1998	US 5978781 A	02-11-1999
		CA 2236744 A	08-11-1998
US 5098130 A	24-03-1992	US 4876000 A	24-10-1989
		DE 3852654 D	09-02-1995
		DE 3852654 T	20-07-1995
		EP 0477169 A	01-04-1992
		JP 2831010 B	02-12-1998
		JP 3503021 T	11-07-1991
		RU 2054338 C	20-02-1996
		WO 8901831 A	09-03-1989
		US 4978145 A	18-12-1990